



Environmental Remediation Group

Olin Corporation

3855 North Ocoee Street, Suite 200
Cleveland, TN 37312
(423) 336-4600
JMCashwell@olin.com

SENT VIA ELECTRONIC MAIL

May 21, 2020

Ms. Lynne Jennings and Ms. Melanie Morash
U. S. Environmental Protection Agency (USEPA), Region 1
5 Post Office Square, Suite 100,
Mail Stop OSRR07-4, Boston, MA 02109-3912

**RE: Human Health Risk Calculations for Potable Use of Private Residential Wells
Olin Chemical Superfund Site – Wilmington, MA**

Dear Ms. Jennings and Ms. Morash:

The attached Technical Memorandum describing Human Health Risk Calculations for Potable Use of Residential Wells has been modified as requested by the United States Environmental Protection Agency. The Memorandum, originally submitted to the USEPA on June 8, 2018, was revised to remove reference to specific property owner names and addresses. No changes were made to the calculations, content, or conclusions of the document.

Please let us know if you have any questions.

Sincerely,

OLIN CORPORATION

A handwritten signature in black ink, consisting of a large, stylized 'J' followed by a horizontal line.

James M. Cashwell
Director, Environmental Remediation

Enclosure

cc: Chinny Esakkiperumal (Olin)
Libby Bowen (Wood)

Memorandum

To James Cashwell, Olin Corporation
From: Michael Murphy, Peter Thompson

Date: May 21, 2020 (Originally submitted June 8, 2018)

Revised Human Health Risk Calculations for Potable Use of Private Residential Wells at Property 1 and Property 2 – Olin Chemical Superfund Site (OCSS) Operable Unit 3 (OU3)

INTRODUCTION AND SUMMARY

This revised document summarizes the preliminary human health risk assessment for theoretical potable use of groundwater from private wells at residences located at Property 1 and Property 2 in Wilmington, MA. This revised document has been prepared in response to United States Environmental Protection Agency (USEPA)'s May 22, 2018 Conditional Approval of the March 6, 2018 *Human Health Risk Calculations for Potable Use of Private Residential Wells at Property 1 and Property 2 in Wilmington, MA associated with the Olin Chemical Superfund Site (OCSS) Operable Unit 3 (OU3)*. Per the USEPA Conditional Approval (attached), several evaluations and discussions have been added to the Uncertainty Analysis of the original memorandum and documentation of those additional evaluations is included in Attachment F. The original preliminary risk assessment was conducted at the request of the USEPA. This assessment is based on a theoretical 26-year, Reasonable Maximum Exposure (RME) residential potable use scenario, including both child and adult residents, and including ingestion of groundwater, dermal contact with groundwater during bathing and showering, and inhalation of volatiles during showering. The risk assessment relies on a comprehensive set of validated laboratory analytical data collected from the private wells at the two residences.

The risk assessment includes four major components:

- hazard identification (data evaluation and selection of chemicals of potential concern (COPCs));
- exposure assessment;
- toxicity assessment; and
- risk characterization.

The risk assessment evaluates, for the scenario described above, exposure to constituents in groundwater via ingestion, dermal contact during bathing/showering, and inhalation of volatile constituents during showering.

Note, this evaluation is just an exercise, as requested by EPA, to estimate any perceived exposure risks – as Olin currently provides bottled water to these residences, and it is our understanding that the water from the private wells is not currently used for drinking or cooking.

The results of the evaluation are summarized as follows. At both Property 1 and Property 2, for the 26-year potable use of groundwater scenario (for considered exposure pathways), the RME

cumulative cancer risk (3×10^{-5}) for a theoretical resident is below 10^{-4} (the upper end of the National Contingency Plan (NCP) risk range of 10^{-6} to 10^{-4}) and the chronic noncancer child hazard index (HI) (0.09 and 0.1, respectively for the two residences) is less than 1. The risk calculation results for both residences meet the NCP and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) health risk management criteria.

Olin has been providing bottled water to the two residences and we assume that the residents are using the water for its intended purpose. Separate calculations have also been performed using groundwater data for the two residences for a theoretical 26-year residential scenario in which the groundwater is used for typical household purposes except that bottled water only (not well water) is used for drinking and cooking. As expected, the RME cumulative cancer risk (8×10^{-7} and 6×10^{-7}) for the two residences) is substantially lower and is actually below both the upper end and the lower end of the National Contingency Plan (NCP) risk range of 10^{-6} to 10^{-4} and the chronic noncancer child hazard index (HI) (0.002 both residences) is substantially less than 1.

HAZARD IDENTIFICATION

These residential wells were initially sampled for chemical analysis in 1990 and they have been included in an on-going quarterly private well monitoring program since 2008. Data from 1995 onwards has been considered as representative of potentially current conditions for the purpose of this assessment. The samples collected prior to 1995 that had analysis for N-nitrosodimethylamine (NDMA) had insufficient detection limits to assess risk. The analytical data considered in this risk assessment for samples from these wells are included in **Table 1**. **Table 1** lists only those analytical parameters that were detected in at least one sample collected from either Property 1 or Property 2. All of the analytical data (for the full list of parameters tested) for all groundwater samples from the two residences are presented in **Table A-1** of **Attachment A**. As noted above, in **Table 1**, results associated with Location “M-24/L-54” are for Property 1 and results for Location “M-24/L-94” are for Property 2. Olin has also provided, in numerous Semi-Annual Status Reports submitted to USEPA, the analytical results for detected parameters for groundwater samples from all private residential wells for each of the quarterly sampling events from 2008 to present.

The analytical laboratory data collected for all private residential wells between 2008 and through 2017 were validated in accordance with the Final Project Operations Plan Volume III-B Quality Assurance Project Plan (QAPP) [MACTEC, 2009]. For SVOCs, validation included 90% Tier II/10% Tier III validation based on USEPA Region I guidelines (USEPA, 1996). For the remaining methods, an Olin Level I review was completed as described in the QAPP. The data validation reports have been submitted to USEPA in the Olin Chemical Superfund Site (OCSS) Semi-Annual Status Reports. Those data validation reports include tabulated data and copies of Laboratory Reports. The analytical data have been considered usable for risk assessment purposes unless otherwise indicated in the data validation reports. Data flagged as “rejected” during the data validation process were not used in the risk assessment.

Prior to summarizing the analytical data, the data were processed to simplify the data, eliminating duplication in cases where compounds have been reported by more than one analytical method (for example as a VOC and an SVOC) in a given sample and for field sample/field duplicate pairs.

https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

This process identifies a single result for each parameter for each method within each sampling location/event for use in the data summary.

Treatment of Method Duplicates: For analytes that were reported using multiple methods, duplicates were resolved as follows:

- For each method pair, if one was a detection and the other was a non-detect, the detected concentration was selected for use in the risk assessment.
- For each method sample pair, if each analytical result was a non-detect then the lower of the two reporting limits (RLs) from the two analyses was selected for use in the risk assessment.
- For each method sample pair, if each analytical result was a detection, then the higher detected concentration was selected for use in the risk assessment.

Treatment of Field Duplicates: For sample locations in which a field duplicate sample has also been collected, duplicates were resolved as follows:

- For each field sample/field duplicate sample pair, if one was a detection and the other was a non-detect, the detected concentration was selected for use in the risk assessment.
- For each field sample/field duplicate sample pair, if each analytical result was a non-detect then the lower of the two RLs from the two analyses was selected for use in the risk assessment.
- For each field sample/field duplicate sample pair, if each analytical result was a detection then the arithmetic mean was selected for use in the risk assessment.

The selected value for each compound/medium/area combination were used in the calculation of summary statistics (including maximum detection and frequency of detection) and of exposure point concentrations.

NDMA in groundwater was the focus of the Site Scoring that resulted in the listing of the OCSS on the National Priorities list. Because NDMA is highly mobile in groundwater, NDMA has been identified as the constituent that defines the horizontal and vertical extent of groundwater impacts at OCSS. NDMA was detected in all but four samples collected from Property 1 and the reporting limit was typically 1.9 nanograms per liter (ng/L) for the non-detects (Method Detection Limit = 0.37 ng/L). For Property 2 samples, reporting limits for non-detects were typically between 1.9 ng/L and 2.1 ng/L, with a few reporting limits in the 10 ng/L to 20 ng/L range. The USEPA Tapwater Regional Screening Level (RSL) (based on cancer risk of 1×10^{-6} and hazard quotient less than 0.1) is 0.11 ng/L¹. The Tapwater RSL was used as the screening level for selection of chemicals of potential concern.

Table 2 documents (RAGS Part D Table 2 format) the selection of COPCs for potable use of groundwater based on samples from Property 1 and Property 2. **Table 2** identifies (separately for the two residences) parameters that have been detected, frequency of detection, range of

¹ As discussed in following sections of this text, the inhalation component of the Tapwater RSL may substantially overestimate the inhalation exposures associated with NDMA in tapwater. Consequently, the Tapwater RSL is likely lower than necessary.

detected concentrations, sample and date of maximum detected concentration, range of reporting limits for non-detects, the risk-based screening level (Tapwater RSL), and potential Applicable or Relevant and Appropriate Requirements/To Be Considered (ARARs/TBCs). The NDMA Tapwater RSL is 0.00011 µg/L (0.11 ng/L). It is based on a target cancer risk of 1×10^{-6} for combined ingestion, dermal, and inhalation of indoor air exposures. A parameter is selected as a COPC if the maximum detected concentration is greater than the risk-based screening level. In addition, parameters without published risk-based screening levels have also been retained as COPCs.

For Property 1, two parameters had maximum concentrations above the risk-based screening level (NDMA and N-nitrosodipropylamine (NDPrA)) and were selected as COPCs. Calcium, magnesium, sodium, chloride, ammonia, and sulfate have been retained as COPCs because no USEPA risk-based screening levels are available for those parameters. However, concentrations of ammonia, sodium, and sulfate in samples from Property 1 are all below USEPA Health Advisories of 30 mg/L, 30 mg/L – 60 mg/L, and 250 mg/L (500 mg/L for acute effects), respectively. In addition, calcium and magnesium are considered essential nutrients and the reported concentrations of those parameters would be associated with potable use daily intakes that are below corresponding Recommended Daily Intakes (USFDA, 2016) as discussed in **Attachment B**. Therefore, although ammonia, sulfate, sodium, calcium, magnesium, and chloride were retained as COPCs (no RSLs available), risk calculations are not necessary to conclude that the risk and hazard associated with the concentrations of these parameters is not significant. The identification of metals and inorganics as COPCs does not mean that the concentrations reported in the wells are elevated above background levels nor that the concentrations are associated with the OCSS. Although hexavalent chromium was reported in one of 22 samples, geochemical information indicates that groundwater conditions are not consistent with the presence of hexavalent chromium. The single detection is considered a false positive, and hexavalent chromium was not retained as a COPC. Consistent with that approach, the Tapwater RSL for trivalent chromium was applied to the results for chromium (not speciated). Three TICs were identified, but their identity is not sufficient for evaluating risk. NDMA and NDPrA have been carried through the quantitative exposure assessment and risk calculations for potable use of groundwater at Property 1.

For Property 2, three parameters had maximum concentrations above the risk-based screening level (NDMA, N-nitrosodipropylamine (NDPrA), and nitrate) and were selected as COPCs. Calcium, magnesium, potassium, sodium, chloride, ammonia, and sulfate have also been retained as COPCs because no risk-based Tapwater screening levels are available for those parameters. However, concentrations of ammonia and sulfate in samples from Property 2 are all below USEPA Health Advisories² of 30 mg/L, and 250 mg/L (500 mg/L for acute effects),

² Text reproduced from the USEPA Health Advisories Table (USEPA, 2012) document: **Lifetime HA**: The concentration of a chemical in drinking water that is not expected to cause any adverse **noncarcinogenic effects** for a lifetime of exposure, incorporating a drinking water RSC factor of contaminant-specific data or a default of 20% of total exposure from all sources. The Lifetime HA is based on exposure of a 70-kg adult consuming 2 liters of water per day. For Lifetime HAs developed for drinking water contaminants before the Lifetime HA policy change to develop Lifetime HAs for all drinking water contaminants regardless of carcinogenicity status in this DWSHA update, the https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

respectively. Sodium concentrations from this residence have fluctuated. Sodium concentrations were below the Health Advisory range (30 mg/L – 60 mg/L) prior to 2011, then were typically above the health advisory range in 2011 and also in 2013 and 2014, but concentrations have been less than the health advisory range from March 2015 through September 2017.

In addition, calcium, magnesium, and potassium are considered essential nutrients and the reported concentrations of those parameters would be associated with potable use daily intakes that are less than corresponding Recommended Daily Intakes (USFDA, 2016) as discussed in **Attachment B**. Therefore, although ammonia, sulfate, sodium, calcium, magnesium, potassium and chloride were retained as COPCs (no RSLs available), risk calculations are not necessary to conclude that the risk and hazard associated with the concentrations of these parameters is not significant. Although hexavalent chromium was reported in two of 23 samples, geochemical information indicates that groundwater conditions are not consistent with the presence of hexavalent chromium. These two detections are considered false positives, and hexavalent chromium was not retained as a COPC. Consistent with that approach, the Tapwater RSL for trivalent chromium was applied to the results for chromium (not speciated). Four TICs were identified with their identity not sufficient for evaluating risk. NDMA, NDPrA, and nitrate have been carried through the quantitative exposure assessment and risk calculations for potable use of groundwater at Property 2.

EXPOSURE ASSESSMENT

Consistent with USEPA guidance (USEPA, 2014), a theoretical 26-year residential exposure scenario has been evaluated. The exposure point concentrations have been identified for COPCs for groundwater ingestion and dermal contact and for inhalation of air in a shower exposure scenario. In addition, the average daily intakes (for ingestion and dermal contact with water) and average air exposures (shower scenario) have been calculated to support the risk calculations.

Exposure Point Concentrations

The groundwater exposure point concentration (EPC) was calculated for each COPC for each of the two residences. Consistent with USEPA risk assessment guidance, (USEPA, 1989, 2002) the groundwater EPC is the lower of the 95% Upper Confidence Limit (UCL) on the mean concentration (calculated using the USEPA ProUCL software (version 5.1)) obtained from the USEPA website (USEPA, 2016) and the maximum detected concentration. **Table 3** documents the groundwater EPCs for the COPCs at the two residences³. **Attachment C** includes the ProUCL output files associated with the UCL calculations. The NDMA groundwater EPCs for Property 1 and Property 2 are 0.015 µg/L and 0.012 µg/L, respectively.

Lifetime HA for Group C carcinogens, as indicated by the 1986 Cancer Guidelines, includes an uncertainty adjustment factor of 10 for possible carcinogenicity.

³ EPCs are identified for all COPCs, but risk calculations will not be performed for essential nutrients and other inorganics and metals that have concentrations that are not likely to be associated with adverse effects based on comparison of potable water use intakes to Recommended Daily Intakes or USEPA Drinking Water Health Advisories.

The air EPCs for inhalation exposures during showering were also calculated for the “volatile” COPC (NDMA) for each of the two residences. The USEPA has defined “volatile” in the 2015 *OSWER Technical Guide for Assessing and Mitigating The Vapor Intrusion Pathway From Subsurface Vapor Sources To Indoor Air* (USEPA 2015a) as substances with a Henry’s Law Constant greater than 1×10^{-5} atm-m³/mole and/or a vapor pressure (vp) greater than 1 mmHg. The most recent USEPA RSL Tables (USEPA, 2017a) also use that definition of “volatile” substances. Based on these criteria, NDMA ($H = 1.8 \times 10^{-6}$ atm-m³/mole and $vp = 2.7$ mm Hg) has been identified by the RSL Tables since 2015 as “volatile” and N-nitrosodipropylamine ($H = 5.4 \times 10^{-6}$ atm-m³/mole and $vp = 0.086$ mm Hg) has not been identified as “volatile”.

The inorganic/metal COPCs are not considered “volatile” and are not evaluated for inhalation exposures. Although ammonia gas is obviously volatile, the predominant ammonia species in groundwater from these wells is expected to be the non-volatile ammonium ion (NH_4^+). Ammonia had low frequency of detection (5/33 and 9/37 for Property 1 and Property 2, respectively) in samples from the two wells, concentrations in both wells were 0.660 mg/L or lower (compared to the USEPA lifetime Health Advisory of 30 mg/L), and at near neutral pH, the ammonia (gas) and ammonium (non-volatile NH_4^+) equilibrium is such that almost all of the ammonia is in the non-volatile ammonium form; volatile ammonium form will be de minimis (see Figure 1 below). For example, at Property 2, observed groundwater pH ranged from 6.3 to 6.94. Using a reported total ammonia concentration of 0.660 mg/L from Property 2 samples, and a pH of 7.0, the estimated non-volatile NH_4^+ concentration would be 0.656 mg/L and the volatile NH_3 concentration would be only 0.0037 mg/L (de minimis). Therefore, ammonia was not carried through the inhalation evaluation. NDMA is the only COPC evaluated for inhalation exposures during showering.

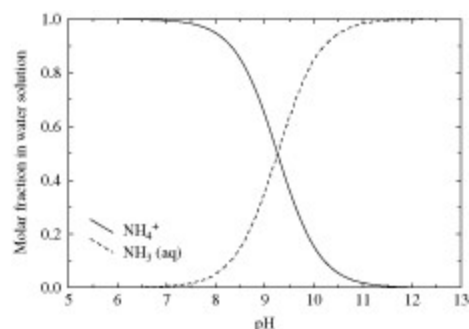


Figure 1. Equilibrium distribution of NH_3 and NH_4^+ in water.

A shower model (Foster & Chrostowski, 1986) was utilized to calculate air exposure point concentrations for a showering scenario. The groundwater EPCs for NDMA in the two residences were used as an input for the shower model to generate a concentration in shower air. The Foster & Chrostowski model was selected to evaluate showering inhalation exposure because it has been used extensively by regulators and risk practitioners, it relies on chemical-specific mass transfer principles and chemical-specific physical parameters to predict the magnitude of VOC volatilization of volatile compounds during bathing and showering, and it has been validated with laboratory data. In addition, the Foster & Chrostowski shower model has been adopted as the basis of the MassDEP’s on-line risk assessment tool for drinking water inhalation exposures.

The calculation used to estimate air concentrations in the bathroom air during a showering event is documented for the child and adult at each of the two residences in spreadsheets included in **Attachment D**. The calculated shower/bathroom air NDMA concentrations associated with the water EPCs for Property 1 for adults and children are 0.002 µg/m³ and 0.0016 µg/m³, respectively. The calculated shower/bathroom air NDMA concentrations associated with the water EPCs for Property 2 for adults and children are 0.0016 µg/m³ and 0.0013 µg/m³, respectively. The calculation of these concentrations is documented in **Tables D-1** and **D-2** of **Attachment D** for the adult resident and child resident, respectively. The adult shower scenario includes daily showering with a total time in the bathroom per event of 42.6 minutes (including 21.3 minutes with the shower operating) and the child scenario includes a total time in the bathroom per event of 32.4 minutes (including 16.2 minutes with the shower operating). The time spent in the bathroom is the 90th percentile time spent bathing taken from the default exposure parameters table (USEPA, 2014) and the time with the shower operating is assumed to be 50% of that time. The bathroom air NDMA EPCs are also presented within the risk calculation **Tables 5, 7, 9, and 11**.

Exposure Scenario and Quantitation of Exposures (Calculation of Average Daily Intakes (water ingestion and dermal contact) and Average Daily Exposures (air inhalation)).

The exposure scenario evaluated is the potable use of groundwater in a residential setting. The scenario includes ingestion of groundwater used for drinking and cooking, dermal contact with groundwater during bathing/showering, and inhalation of constituents volatilizing from groundwater into indoor air during showering or bathing. Consistent with the Recommended Default Exposure Factors (USEPA, 2014), it is assumed that the “resident” includes both the child (ages 0 through 6) and an adult (20 year duration). The exposure parameter values (such as water ingestion rate, bodyweight, skin surface area for bathing/showering, frequency of exposure, bathing/showering event duration (exposure time), and duration of exposure) for each of the two age groups are taken primarily from the Recommended Default Exposure Factors Table (USEPA, 2014) and the values are identified in **Table E-1** (ingestion and dermal exposure) and **Table E-2** (inhalation exposure) of **Attachment E**. **Attachment E** also includes documentation of the dermal exposure assessment calculations.

Consistent with Risk Assessment Guidance for Risk Assessment, Volume I, Part A (USEPA, 1989), Part E (USEPA, 2004) and Part F (USEPA, 2009) exposures are quantified in two major ways: 1) calculation of a dose or daily intake (oral and dermal exposures) or 2) calculation of a representative exposure concentration (inhalation).

By combining the EPC and the receptor exposure parameters, the daily intake (ingestion and dermal) or representative exposure concentration (air) is calculated. Those measures of exposure are subsequently combined with toxicity values to characterize health risks.

For ingestion and dermal exposure routes, the general equation for calculating dose/intake is as follows:

$$Dose = \frac{EPC \times CR \times EF \times ED}{AT \times BW}$$

Where:

Dose	=	Average daily dose of COPC from soil at the exposure point during the period of exposure (mg/kg/day)
EPC	=	Exposure Point Concentration (mg/kg or mg/L)
CR	=	Contact Rate (mg/day) Ingestion: Ingestion rate (mg/day) Dermal absorption: Skin surface area (cm ² /day) x adherence factor (mg/cm ²) [groundwater only] x absorption factor (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
AT	=	Averaging Time (days) (equal to ED for non-cancer evaluation; equal to 70 years for cancer evaluation)
BW	=	Body Weight (kg)

The methodology for evaluating inhalation exposures differs from that used for the ingestion and dermal routes because toxic effects associated with inhalation exposures are a function of the COPC concentration in air rather than of the intake/dose as is the case for ingestion and dermal exposures (USEPA, 2009a). Hence, inhalation exposures are quantified in terms of average COPC concentration in air over the exposure period for non-cancer risk calculations and the lifetime average COPC concentration in air for cancer risk calculations. The exposure-response (toxicity) values used to calculate risks for inhalation are Reference Concentrations (RfCs) presented in dimensions of milligrams per cubic meter (mg/m³) and Inhalation Unit Risks (URs) presented in dimensions of risk per micrograms per cubic meter [µg/m³]-1 instead of Reference Doses (RfDs) and Cancer Slope Factors (CSFs), which are used to calculate risks for oral and dermal contact. Because a representative concentration and not dose is the basis for inhalation risk assessment, exposure parameters such as body weight and ventilation rate are not typically used in calculating risk estimates for inhalation exposures (USEPA, 2009a). The general equation for calculating chemical exposure via inhalation is as follows:

$$EC_{air} = \frac{CA \times ET \times EF \times ED}{CF \times AT}$$

Where:

EC _{air}	=	representative exposure concentration of COPC in the air at the exposure point during the period of exposure (mg/m ³)
CA	=	concentration of the COPC in air (mg/m ³)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
ET	=	exposure time (hours/day)
CF	=	conversion factor (24 hours/day)
AT	=	averaging time (for cancer risk calculations, AT = 70 years times 365 days per year; for noncancer HI calculations, AT = ED times 365 days per year).

The specific equations used to calculate doses/intakes for ingestion and dermal contact with groundwater and inhalation of indoor air are those presented in USEPA guidance (USEPA, 1989; 2004; 2009a), and are provided in the exposure parameter tables (**Tables E-1, E-2, and E-3**). **Tables E-1 and E-2** also document the calculation of the numerical values for the term DA_{event} shown in the equations included in **Tables E-1 and E-2**. Doses/intakes and representative exposure concentrations are calculated separately for cancer risk calculations (based on lifetime average) and noncancer HI calculations (based on average for exposure period). The doses/intakes and representative air exposure concentrations are documented within the risk calculation **Tables 5, 7, 9, and 11**. The doses and representative air exposure concentrations are subsequently utilized with toxicity information to calculate cancer risk and noncancer hazard index estimates.

TOXICITY ASSESSMENT

As mentioned above, consistent with USEPA guidance, RfDs and CSFs are used in the calculation of noncancer HI and cancer risk for ingestion and dermal (adjusted oral values) exposures to water. Similarly, RfCs and inhalation URs are used in the calculation of noncancer HI and cancer risk for inhalation exposures to indoor air.

The hierarchy of sources for dose-response values for CERCLA sites (USEPA, 2003a) identifying three tiers of toxicity value sources, has been utilized in identifying dose-response values for this preliminary human health risk assessment. The toxicity values used in the risk assessment are identified in **Tables 5, 7, 9, and 11**. Toxicity values consistent with CERCLA risk assessment procedures and practices were identified for NDMA, N-nitrosodipropylamine, and nitrate. The toxicity values for NDMA, N-nitrosodipropylamine, and nitrate were obtained first from the main (Tier I) source of dose-response values (Integrated Risk Information System or IRIS), which is a database established by USEPA containing all validated data on many toxic substances found at hazardous waste sites (USEPA, 2018: Accessed February 2018). If values were not available from the first tier, the USEPA RSL Tables (USEPA, 2017a) were utilized, which identify values from Tier II and Tier III sources when values are not available from a Tier I source. The toxicity values utilized in this risk assessment are discussed in the following text.

NDMA

NDMA is classified as B2, probable human carcinogen (USEPA, 2018). The CSF and inhalation UR are based on studies with rodents and monkeys. Human data concerning carcinogenicity of NDMA for use in deriving toxicity values are not adequate for deriving carcinogenic toxicity factors for individual nitrosamine compounds (the available data are associated with mixtures of nitrosamines). Non-carcinogenic liver impacts of acute NDMA exposure have been reported in humans and animals and of subchronic and chronic exposures in animals (USEPA, 2007, Agency for Toxic Substances and Disease Registry (ATSDR), 1989a).

NDMA toxicity values obtained from USEPA and other sources used in this assessment include:

- Oral CSF: 51 per mg/kg/day – IRIS (USEPA, 2018) (Tier 1)
- Inhalation Unit Risk (UR): 1.4×10^{-2} per $\mu\text{g}/\text{m}^3$ – IRIS (USEPA, 2018) (Tier 1)

https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

- Oral RfD: 8×10^{-6} mg/kg/day – PPRTV (USEPA, 2007) (Tier 2)
- Inhalation RfC: $0.04 \mu\text{g}/\text{m}^3$ – APPENDIX PPRTV SCREEN (USEPA, 2007) (Tier 3)

The published oral CSF and oral RfD were considered appropriate for evaluating both ingestion and dermal exposures as discussed in the following text. Oral cancer CSFs and non-cancer RfDs were developed to evaluate risk associated with the ingestion exposure route (typically based on the applied dose). In accordance with USEPA guidance (USEPA, 2004), dermal dose-response values are calculated from oral dose-response values using an oral absorption factor. The oral absorption factor represents the fraction of ingested amount that is absorbed from the gastrointestinal tract following oral administration of a substance. The absorbed dose represents the amount of substance that is potentially available for biological interaction. The calculated dermal dose-response value is appropriate for evaluating the absorbed dermal doses.

Thus, for potentially carcinogenic substances, the dermal dose-response value is calculated as follows:

$$CSF_d = CSF_o / \text{Oral ABS}$$

The dermal dose-response value for evaluating non-carcinogenic effects is calculated as follows:

$$RfD_d = RfD_o \times \text{Oral ABS}$$

Chemical-specific oral absorption factor (ABS) values are presented in EXHIBIT 4-1 of USEPA's 2004 Risk Assessment Guidance For Superfund, Volume 1, Part E (dermal risk assessment guidance). Neither NDMA nor NDPrA is listed in that table. However, the USEPA RSL Tables (USEPA, 2017a) do contain chemical-specific values for the term "GIABS" which is the oral absorption factor to be considered in determining if an alternative dermal dose-response value needs to be derived from the oral dose-response value. The value of the GIABS term for NDMA and NDPrA in the RSL Tables is 1. In those tables, the RSL User's Guide states "Note: if the GIABS is >50% then it is set to 100% for the calculation of dermal toxicity values". That approach reflects the USEPA position that if the oral absorption efficiency is greater than 50%, there is no need to adjust the toxicity value for evaluating dermal exposure. In the actual RSL tables, the GIABS value is shown as "1" (not 100%). When that oral ABS is equal to 1, consistent with the equations above, the dermal CSF is equal to the oral CSF and the dermal RfD is equal to the oral RfD. Therefore, the NDMA and NDPrA dermal CSF and RfD are set equal to the corresponding oral values.

Please note that, as discussed in subsection Adjustment for Early Life Exposures to Carcinogens with a Mutagenic Mode of Action below, the NDMA oral CSF and inhalation UR identified above were both adjusted to address susceptibility from exposures to carcinogens because this risk assessment includes residents, including children and adults and NDMA has been reported to have a mutagenic mode of action (USEPA, 2005 (Table 1b), 2017a).

NDPrA

NDPrA is classified as B2, probable human carcinogen (USEPA, 2018). The oral CSF is based on studies with rodents and monkeys. Non-carcinogenic liver impacts of acute NDPrA exposure have been reported in humans and animals and of subchronic and chronic exposures in animals (ATSDR, 1989b).

Human data concerning carcinogenicity of NDPrA for use in deriving toxicity values are not adequate for deriving carcinogenic toxicity factors for individual nitrosamine compounds (the available data are associated with mixtures of nitrosamines (USEPA, 2018).

NDPrA toxicity values obtained from USEPA and other sources used in this assessment include:

- Oral CSF: 7 per mg/kg/day – IRIS (USEPA, 2018) (Tier 1)
- Oral RfD: not available

Consistent with the discussion above for NDMA, because the oral absorption of NDPrA is greater than 50% and USEPA identifies the GIABS value as “1”, the dermal CSF is equal to the corresponding oral value.

Please note that the oral CSF identified above was not adjusted to address susceptibility from early life stage exposures to carcinogens because NDPrA is not classified as a mutagen in the USEPA RSL Tables (USEPA, 2017a).

Nitrate

Nitrate is not considered a carcinogen and carcinogenicity of nitrate is not evaluated in the USEPA IRIS database (USEPA, 2018).

Therefore, there are no carcinogenic toxicity values required for nitrate in this risk assessment. Nitrate also is not volatile and therefore, no inhalation toxicity values were required for this risk assessment. The sensitive toxicity endpoint for nitrate has been identified (USEPA, 2018) as methemoglobinemia in infants (observed when formula is prepared with drinking water). USEPA’s IRIS database indicates most cases of infant methemoglobinemia are associated with exposure to nitrate in drinking water used to prepare infants’ formula at levels >20 mg/L of nitrate-nitrogen. Nitrate was not detected in water samples from Property 1. The maximum detected concentration in water samples from Property 2 was 4.8 mg/L and the EPC for Property 2 was 1.9 mg/L.

The toxicity values for nitrate used in this risk assessment are:

- Oral RfD: 1.6 mg/kg/day – IRIS 2018 (Tier 1)
- Because the “GIABS” is listed as 1 in the USEPA RSL Tables (USEPA, 2017a), the dermal RfD is equal to the oral RfD.

Although calcium, magnesium, and potassium were retained as COPCs (no ARAR-based or risk-based screening levels available), they are considered essential nutrients and they have not been

https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

included in risk calculations. To support that decision, estimated drinking water intakes of those constituents for all of the private residential wells have been compared to Recommended Daily Intakes (RDI) identified by the US Food and Drug Administration (USFDA, 2016) as described in (Attachment B). The RDI values are clearly considered safe intake levels. That comparison concluded that for the private residential potable well scenarios, the estimated daily intake from drinking water as percent of the corresponding RDI ranges from 0.2 to 19 percent for calcium, magnesium, potassium, and sodium, indicating that these essential nutrients are present at concentrations that would not be anticipated to be toxic. This confirms that the decision to consider these parameters as essential nutrients that are not present at potentially toxic levels and that quantitative evaluation of risk for these parameters is not necessary, consistent with USEPA guidance (USEPA, 1989).

Chronic toxicity values are not available for the other COPCs for Property 1 (ammonia, chloride and sulfate) and Property 2 (ammonia, chloride and sulfate). EPCs for ammonia in Property 1 and Property 2 samples (0.160 mg/L and 0.072 mg/L, respectively) are well below the USEPA Lifetime Health Advisory for ammonia which is 30 mg/L (USEPA, 2012). The EPCs of sulfate in Property 1 and Property 2 samples (27 mg/L and 21 mg/L, respectively) are below the Secondary Maximum Contaminant Level of 250 mg/L and also well below the USEPA health advisory for acute effects (absence of laxative effects) of 500 mg/L (USEPA, 2003b). No Health Advisories or RDIs were identified for chloride. The EPCs for sodium in Property 1 and Property 2 samples (28.7 mg/L and 52.5 mg/L) are within the range of 30 mg/L to 60 mg/L that is a recommended goal based on taste, in the USEPA Health Advisory for sodium (USEPA, 2003c). These values are, however, above the current USEPA guideline of 20 mg/L that is based on sodium-restricted diets. The USEPA sodium health advisory indicates that drinking water containing between 30 and 60 mg/L sodium is unlikely to be perceived as salty by most individuals and would contribute only 2.5% to 5% of the dietary goal if tap water consumption is 2 L/day.

Adjustment for Early Life Exposures to Carcinogens with a Mutagenic Mode of Action

USEPA has developed guidance for characterizing cancer susceptibility associated with early life exposures (e.g., young children) to potentially carcinogenic chemicals (USEPA, 2005). The approach developed by USEPA to characterize cancer risks for early life stages includes consideration of differences in physiology and exposure potential between children and adults, as well as differences in susceptibility to tumor development between children and adults. Physiological and behavioral differences are accounted for in the exposure assessment, whereby age-specific exposure parameters (e.g., body weights, ingestion rates, inhalation rates, contact frequencies) are applied to the various age groups evaluated in the risk assessment. Differences in susceptibility to tumor development are accounted for by considering the carcinogenic mode of action in accordance with the mode of action framework developed by USEPA (USEPA, 2005). CSFs and URs for carcinogens that act with a mutagenic mode of action are assigned Age-Dependent Adjustment Factors (ADAFs) to account for early life stage susceptibility.

Consistent with USEPA guidance, an ADAF has been applied to published oral and dermal CSFs and the inhalation UR for NDMA to calculate risk for the resident receptor. USEPA guidance (USEPA, 2005) recommends the following ADAFs:

- Birth to second birthday, ADAF = 10
- Second birthday to sixteenth birthday, ADAF = 3
- After sixteenth birthday, no ADAF.

Consistent with approaches included in the USEPA RSL Tables and described in the RSL Tables User's Guide, the ADAFs applied for the resident child and adult scenarios in this risk assessment were derived as follows.

Child (birth to sixth birthday):

$$\text{Child ADAF} = [(10 \times 2 \text{ yrs}) + (3 \times 4 \text{ yrs})] / 6 \text{ yrs} = 5.33$$

Adult (sixth birthday to twenty-sixth birthday):

$$\text{Adult ADAF} = [(3 \times 10 \text{ yrs}) + (1 \times 10 \text{ yrs})] / 20 \text{ yrs} = 2.0$$

This approach is consistent with the USEPA RSL Tables approach. The NDMA oral and dermal CSFs (both 51 per mg/kg/day) were adjusted to 102 per mg/kg/day and 270 per mg/kg/day for the adult and child, respectively, for use in risk calculations. Note that the "adult" receptor includes the 6 to 16 age group. The inhalation unit risk (1.4×10^{-2} per $\mu\text{g}/\text{m}^3$) was adjusted to 2.8×10^{-2} and 7.4×10^{-2} per $\mu\text{g}/\text{m}^3$ and for the adult and child, respectively. These adjusted CSF and inhalation UR values are documented in the risk calculation spreadsheets in **Tables 5, 7, 9, and 11**.

RISK CHARACTERIZATION

Quantitative estimates of both carcinogenic and non-carcinogenic hazards are calculated for the potable use of groundwater for each of the two residences in accordance with USEPA (1989) guidance. The calculated cancer risk and non-cancer hazards are evaluated in the context of risk management criteria established in the NCP and discussed in the preamble to the NCP (USEPA, 1990), the USEPA directive Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions (USEPA, 1991b), and the USEPA directive Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration (USEPA, 2009b). The results of the baseline risk assessment are compared to CERCLA risk management criteria. The cancer risk estimates for a site are compared to the cancer risk range of 10^{-6} (one in a million) to 10^{-4} (one in ten-thousand). Risks at or below 10^{-4} (upper end of the NCP risk range) do not generally warrant a response action (USEPA, 1990, 1991b). Risks greater than 10^{-4} generally warrant development and evaluation of remedial alternatives. Non-cancer risks are compared to a HI value of 1, which corresponds to levels of exposure that people (including sensitive individuals) could experience without expected adverse effects.

The 2009 USEPA Recommended Process for Restoring Contaminated Groundwater at Superfund Sites (USEPA, 2009b) in a section discussing whether CERCLA remedial action is warranted, states "A CERCLA remedial action generally is appropriate ...when the estimated risk calculated in a risk assessment exceeds a noncarcinogenic level for an adverse health effect or the upper end of the NCP risk range for "cumulative carcinogenic site risk to an individual based

on reasonable maximum exposure for both current and future land use”; the non-carcinogenic hazard index is greater than one (using the reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use”).

Risk Calculation Methodology

An estimate of the excess lifetime cancer risk (ELCR) associated with exposure to each COPC is calculated by multiplying the exposure route pathway-specific lifetime average daily dose (e.g., ingestion exposure for groundwater) or lifetime average exposure concentration (e.g., inhalation of vapors) by its exposure route-specific CSF (e.g., oral CSF) or UR.

$$ELCR = \text{Lifetime Average Daily Dose or Exposure (mg/kg/day or } \mu\text{g/m}^3) \times CSF \text{ (mg/kg/day)}^{-1} \text{ or } UR \text{ (}\mu\text{g/m}^3\text{)}^{-1}$$

The ELCR represents an upper bound of the probability of an individual developing cancer over a lifetime as the result of exposure to a COPC. The ELCR is calculated for NDMA and NDPrA for each of the two residences. The ELCR for all carcinogenic COPCs (NDMA and NDPrA) in groundwater are summed to identify a route-specific total ELCR (e.g., groundwater ingestion) and the ELCR for all exposure routes for groundwater (ingestion and dermal contact as well as inhalation of volatiles released from groundwater) are summed to yield a total medium ELCR (e.g., for groundwater).

The non-cancer HQ associated with exposure to each COPC is calculated by dividing the exposure route pathway-specific average daily dose or exposure concentration by its exposure route-specific RfD or RfC.

$$HQ = \text{Average Daily Dose or Exposure (mg/kg/day or } \mu\text{g/m}^3) / RfD \text{ (mg/kg/day) or RfC (}\mu\text{g/m}^3\text{)}$$

The HQ is calculated for each COPC for each medium and exposure route combination for each receptor at each of the residences. For a given medium/receptor/age group combination (e.g., groundwater resident child), HQs for all COPCs are summed by route (e.g., dermal contact) to identify a medium/route HI, and the HIs for multiple exposure routes (e.g., incidental ingestion, dermal contact, and inhalation during showering) are summed to identify a medium-specific total HI (e.g., for groundwater ingestion, dermal contact, and inhalation of volatiles). Because HIs are not additive across age groups, the higher HI between the two age groups (child and adult), in this case) is selected as the representative HI for the resident. An HI less than 1 indicates that non-carcinogenic adverse effects are unlikely to occur as a result of COPC exposure. HIs greater than 1 indicate that adverse effects are possible.

Risk Calculation Results and Conclusions

The risk calculations are documented in **Tables 4 through 7** for Property 1 and in **Tables 8 through 11** for Property 2. **Tables 4 through 11** are consistent with the requirements for documenting risk calculations included in Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part D), Final (USEPA, 2001). **Table 12** summarizes the cumulative ELCR and cumulative HI for the two residences.

For both Property 1 and Property 2, the 26-year potable use of groundwater scenario (assuming ingestion of groundwater, dermal contact with groundwater during bathing and showering, and inhalation of volatiles during showering), the RME cumulative cancer risk (3×10^{-5}) for a theoretical resident is below 10^{-4} , the upper end of the NCP risk range (10^{-6} to 10^{-4}) and the chronic non-cancer child HI (0.09 and 0.1, respectively for the two residences) is less than 1. The risk calculation results for both residences meet the NCP and CERCLA health risk management criteria.

UNCERTAINTY ANALYSIS

This section identifies and discusses uncertainties in the risk assessment. These uncertainties are identified to provide perspective on the quantitative risk estimates. Risk assessments rely not just on measured data, or certain facts, but also on assumptions and estimates, and also policy decisions, in the face of limited or nonexistent data. Historically, many risk assessments have used highly conservative assumptions in the place of unavailable data, with the net result often being a substantial overestimation of potential risks. It is important, however, to evaluate the assumptions and choices made in any risk assessment to evaluate their impact on the results and conclusions.

The following types of uncertainties should be considered in any risk assessment:

- uncertainties in the nature and extent of release of COPC;
- uncertainties associated with the identification of future land uses and potential receptors;
- uncertainties in estimating the frequency, duration, and magnitude of possible exposures (including the identification of representative EPCs in environmental media);
- uncertainties associated with assigning exposure parameters to a heterogeneous population that includes both men and women and young and old (e.g., BW and ingestion rates);
- uncertainties in estimating CSFs and URs and/or non-carcinogenic measures of toxicity (e.g., RfDs or RfCs); and

Nature and Extent of Release and Selection of COPCs

These two residential wells have been sampled extensively beginning in 1990 as part of initial investigations of groundwater and then as part of the semi-annual and then quarterly residential well monitoring program which began in October 2008 and still continues. As shown in **Table 1**, **Table 2**, and **Table A-1** samples from these wells have been analyzed for VOCs, SVOCs, metals and inorganics, and NDMA and NDPrA. VOC analysis was not continued in the monitoring program because only MTBE (not from the OCSS) was detected in samples from Property 1 in 2008 and 2009 and no VOCs were detected in samples from Property 2 in 2008 and 2009. Other than NDMA, SVOCs were detected very infrequently. The most frequently detected parameters in samples from these wells include NDMA, calcium, chloride, sodium, nitrate, and sulfate. The number of samples analyzed for these parameters in each of the two wells ranges from 23 to 37. The available data set is considered comprehensive and representative for evaluating Site-related risks.

Hexavalent chromium was reported at very low frequency (in 2 of 23 samples and 1 of 22 samples for Property 1 and Property 2, respectively). These results are considered false positives, based on the geochemical conditions of the groundwater as discussed in the Fate and Transport section of the OU3 Remedial Investigation Report (in preparation). Geochemical conditions in groundwater favor the trivalent form of chromium. Since the hexavalent chromium detections are considered false positives, then the use of the trivalent chromium Tapwater RSL for screening chromium (total) analytical results for COPC selection is appropriate

Receptors and Land Use

The evaluation of theoretical child and adult residential receptors and potable use of groundwater is consistent with current and reasonably foreseeable future use. This is the most conservative (health protective) scenario typically evaluated. It should be noted that this risk assessment evaluates a theoretical typical residential receptor exposure scenario. This assessment is not an assessment of exposures for current or historical residents at the two residences.

Exposure Assessment

The derivation of exposure point concentrations for groundwater ingestion and dermal contact as well as for inhalation exposures during showering and the identification of exposure parameter values for three different exposure routes are the most significant topics with respect to potential uncertainties in the risk assessment.

Exposure Point Concentrations

The EPCs for ingestion and dermal contact with groundwater were derived consistent with identification of RME for the residential receptors for a CERCLA risk assessment. The selection of the lower of the maximum detected concentration and the UCL on the mean is conservative (health protective) and consistent with USEPA risk assessment guidance.

The groundwater EPCs used to evaluate ingestion and dermal contact exposures and as inputs to the shower model (NDMA only) are based on the analytical data collected during sampling conducted from 1995 through 2017. The available analytical data for NDMA and NDPrA are primarily from 2005 through 2017 (32 data points for Property 1 and 36 data points for Property 2). These data are considered representative of chronic exposures for the potable use scenario. For the two residences, the NDMA (the primary risk contributor) concentrations from this time period do not show any obvious increasing or decreasing trend, as shown in **Figures F-1 and F-2 in Attachment F**. For this uncertainty analysis, EPCs for NDMA have also been calculated using a subset of the available data – specifically, the NDMA data from 2015 through 2017 (11 data points for Property 1 and 12 data points for Property 2). The data sets and the calculated EPCs for the entire dataset and the more recent three years of data are compared below.

Table F-1 in Attachment F summarizes the NDMA data and EPCs for the entire data sets and the recent 3-year data sets for the two residences. The frequency of detection is similar for the entire NDMA data set (91% for Property 1 and 64% for Property 2) and the recent 3-year data set (82% for Property 1 and 67% for Property 2). The range of detected concentrations for the entire

and recent 3-year data sets are also very similar for both residences. **For Property 1, the NDMA UCLs (which are also EPCs) are almost identical for the entire (0.0149 µg/L) and recent (0.015 µg/L) data sets.** For Property 2, the two UCLs generated by ProUCL for the recent 3-year data set (0.0604 µg/L (higher than the maximum detected value) and 0.0353 µg/L) are higher than the UCL for the entire data set (0.012 µg/L). The atypical NDMA concentration for Property 2 (0.056 µg/L) is the maximum concentration in both the entire and recent data sets. However, that result has a bigger impact on the UCL (increases it) in the smaller, recent data set than in the entire data set. Visual inspection of **Figure F-2** shows the atypical (i.e., anomalous) nature of that maximum concentration, which is not in line with any previous results from that well, especially in the last three years. The re-sample collected from Property 2 three weeks after that atypical (anomalous) maximum result was reported as a non-detect (reporting limit of 0.0019 µg/L) and the next quarterly sample result (approximately seven weeks after the atypical result) was 0.0029 µg/L. As shown in **Figure F-2**, the 0.056 µg/L result is not representative of long-term exposures at Property 2. Therefore, the NDMA UCL for the recent 3-year data set has been calculated without the atypical maximum concentration. **The UCL for the recent 3-year data set is 0.0053 µg/L, which is lower than the corresponding UCL (and EPC) for the entire data set for Property 2.** That UCL would be selected as the EPC for the 3-year data set for Property 2. The ProUCL output files for the calculation of NDMA UCLs for the recent 3-year data sets for Property 1 and Property 2 and for Property 2 excluding the atypical maximum are included in **Attachment F (Tables F-2, F-3, and F-4).**

Since the NDMA EPCs for Property 1 and Property 2 for the recent 3-year data set are essentially identical and lower, respectively, than the NDMA EPCs for the entire NDMA data sets, using only data from the last three years of sampling would not change the conclusions of the risk assessment.

The EPCs for inhalation of volatiles during showering were derived using the Foster & Chrostowski model (Foster and Chrostowski, 1986). This model has been chosen instead of the use of the model that was used in the Tapwater RSL table for deriving the inhalation component of the Tapwater RSL. The following text outlines the rationale for using the Foster & Chrostowski rather than the Tapwater RSL Table model.

The RSL Tables User's Guide (USEPA, 2017b) states clearly that USEPA acknowledges alternate approaches for risk assessment may be more appropriate for some sites than those approaches used in the derivation of the RSLs. The RSL User's Guide states:

This guidance sets forth a recommended, but not mandatory, approach based upon currently available information with respect to risk assessment for response actions at CERCLA sites. This document does not establish binding rules. Alternative approaches for risk assessment may be found to be more appropriate at specific sites (e.g., where site circumstances do not match the underlying assumptions, conditions and models of the guidance). The decision whether to use an alternative approach and a description of any such approach should be documented for such sites.

Accordingly, when comments are received at individual CERCLA sites questioning the use of the approaches recommended in this guidance, the comments should be considered and an explanation provided for the selected approach.

This risk assessment is consistent with the MassDEP's approach for assessing drinking water inhalation exposures. This risk assessment does not evaluate inhalation exposures associated with potable use of groundwater based on the model that USEPA has used to derive the inhalation component of the Tapwater RSL for NDMA. The inhalation component of the USEPA Tapwater RSL for NDMA was derived by application of a model (that is based on a 1990 published article by Andelman) that uses a single, "one size fits all" transfer efficiency (50% of the concentration of volatile constituents in water is transferred from water to air) for all water uses in a home (bathing, showering, laundry, cooking, dishwashing, toilets, and cleaning). The estimated 50% transfer efficiency is based on information available concerning radon.

The Andelman paper estimated average daily water use (720 L/day) and daily air flow through a typical home ($150,000 \text{ L} \times 0.25 \text{ exchanges/hr} \times 24 \text{ hr/day} = 900,000 \text{ L}$). That information suggests the mass of a volatile constituent released from 720 liters of water (50% of the constituent present in the water, estimated for radon) would be "diluted" by 900,000 L of air during a 24-hour period. An average air concentration for a 24-hour period assuming 1 mg/L VOC in the water could be calculated as: the mass released to air (concentration in water (1 mg/L) \times transfer efficiency (50%) \times volume of water (720 L) = 360 mg VOC divided by the daily air flow through the residence (volume of residence (900,000 L (calculated above) yielding an average VOC concentration in air of 0.0004 mg/L. With units conversion, the 0.0004 mg/L in air $\times 1000 \text{ L/m}^3 = 0.4 \text{ mg/m}^3$.

Using the relationship from the example above, the "volatilization" constant K would be 0.4 L/m^3 and the relationship between the water concentration (as mg/L) and the air concentration (as mg/m^3) would be $C_a = C_w \text{ (as mg/L)} \times 0.4 \text{ L/m}^3$.

Note that the estimated air concentration in the example above is 4×10^{-4} times the concentration in the water ($C_a = 4 \times 10^{-4} \times C_w$). The 1990 Andelman paper stated that the expected range of indoor air concentrations is $C_a \text{ (as mg/L)} = (0.1 \text{ to } 5) \times 10^{-4} \times C_w \text{ (as mg/L)}$.

Considering the range of expected ratios (0.1×10^{-4} to 5×10^{-4}) of indoor air (mg/L) to water concentrations (mg/L) identified in the 1990 Andelman paper, the corresponding range of "volatilization" constants (K) would be 0.01 L/m^3 to 0.5 L/m^3 .

As described in the USEPA RAGS Part B (USEPA, 1991), and as included in the USEPA RSL Table User's Guide, USEPA has selected a "volatilization" constant (K) of 0.5 L/m^3 for calculating inhalation-based RSLs for tapwater. This value is the high end value of the expected range of K values that would result from the 1990 Andelman paper. It is notable there is a 50-fold difference between the lower end and upper end of that range. Because the K value based on the Andelman paper is associated with overall household use of water (not a specific activity such as bathing or showering), and it is associated with estimated average daily air concentrations, USEPA has included 24 hr/day, 350 days/yr exposures to residential indoor air in the calculation of the Tapwater RSL for NDMA.

The simple model used in the derivation of the inhalation component of the NDMA Tapwater RSL is highly uncertain and there are multiple technical concerns about the use of that model to evaluate exposures and risks for NDMA.

- The model is not chemical-specific. It treats all “volatile” constituents equally, regardless of their chemical and physical characteristics such as Henry’s Law constants and vapor pressure. NDMA’s Henry’s law constant is orders of magnitude lower than corresponding values for the volatile organic compounds that are typically encountered in groundwater;
- Obviously, the physical and chemical characteristics of NDMA have not changed in recent years. However, USEPA previously did not classify NDMA as “volatile” and therefore, the Tapwater RSL did not contain an inhalation component and drinking water risk assessments did not include an inhalation component (vapors released from water). Beginning in 2015, the inhalation pathway was included in the NDMA Tapwater RSL derivation because the NDMA vapor pressure (2.7 mm Hg) is above one of the parameters considered for “volatile” criteria (Vapor pressure greater than 1 mm Hg).
- There are other models available that include chemical-specific parameters, particularly published shower models that have been used extensively under CERCLA and one model in particular, the Foster & Chrostowski shower model has been adopted as the basis of the MassDEP’s on-line risk assessment tool for drinking water;
- NDMA is a semi-volatile compound with a very low Henry’s Law constant, indicating equilibrium between water and air very strongly favors water phase. The table below presents the NDMA Henry’s Law constant along with constants for commonly encountered volatile organic compounds and also for some other semi-volatile compounds. The radon Henry’s Law constant is 35,135 times the corresponding NDMA Henry’s Law constant. The trichloroethene Henry’s Law constant is 5,405 times the corresponding NDMA Henry’s Law constant. The use of a default “transfer efficiency” of 50% (from water to air) that is based on radon to evaluate transfer of NDMA from water to air does not appear to be appropriate since the Henry’s Law constant for NDMA is more than four orders of magnitude lower than that of radon.

Substance	Henry’s Law Constant (unitless) (1)
trimethylpentenes	30
radon	2.6 (2)
vinyl chloride	1.1
tetrachloroethene	0.72
trichloroethene	0.4
1,3,5-trimethylbenzene	0.36
ethylbenzene	0.32
xylenes	0.27
benzene	0.23
methylnaphthalene	0.021
naphthalene	0.018
NDMA	0.000074
Bis(2-ethylhexyl)phthalate	0.000011
(1) USEPA RSL Chemical-Specific Parameters Supporting Table, November 2017.	
(2) Kil Yong Lee, Yoon Yeol Yoon, Kyung Seok Ko, 2010. Determination of the emanation coefficient and the Henry’s law constant for the groundwater radon, Journal of Radioanalytical and Nuclear Chemistry, Vol. 286, Issue 2, pp. 381-385, November.	

The model used in the RSL approach assumes that the mass of volatiles released from water use is released into the indoor air and that the exposure can be characterized as a 24-hr per day

https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

exposure. As stated in the 1990 Andelman paper, this approach does not address the time and space variations that would be encountered by a receptor throughout the day.

- The model used in derivation of the RSL would predict that 10 ng/L NDMA in tapwater would result in a 24-hr average indoor air NDMA concentration of 5 ng/m³. However, the Henry's Law constant suggests that with equilibrium between water and air, the estimated indoor air concentration when the water concentration of NDMA is 10 ng/L would be only 0.74 ng/m³. The RSL model would unrealistically predict a 24-hr average concentration that is approximately seven times the calculated equilibrium concentration.
- Lastly, the model used in the RSL derivation assumes the receptor is exposed to volatiles released from potable use water into indoor air 24 hours per day, 350 days per year, for the entire 26 year exposure period.

To provide a point of reference, the whole house indoor air NDMA EPCs have been calculated using the USEPA version of the Andelman model and the lower end of the range of possible K values (0.01 L/m³) [not the value of 0.5 L/m³ used in the tap water RSL calculation]. This calculation is based on the equation:

$$C_{\text{air}} = C_{\text{water}} * K$$

Where:

C_{air} = whole house air concentration (µg/m³);
 C_{water} = concentration in water (µg/L) [0.0149 µg/L and 0.0121 µg/L for Property 1 and Property 2]; and
K = volatilization constant (L/m³)

The USEPA approach for application of the Andelman model assumes a resident is exposed to the estimated whole house concentration 24 hours per day 350 days per year for 26 years. Based on those assumptions, the resident indoor air whole house concentration and average concentrations for hazard index calculations are 0.000149 µg/m³ and 0.000121 µg/m³ for Property 1 and Property 2, respectively (see **Table F-5**). These concentrations are lower, as expected, than the bathroom NDMA air concentrations calculated with the Foster & Chrostowski model for Property 1 (0.002 µg/m³) and Property 2 (0.0016 µg/m³) (see **Table D-1**).

The average concentrations used for hazard quotient calculations using the Andelman model are also 0.000149 µg/m³ and 0.000121 µg/m³ for Property 1 and Property 2, respectively. The average concentrations used for hazard quotient calculations for adults using the Foster & Chrostowski model are (0.000059 µg/m³ and 0.000047 µg/m³ for Property 1 and Property 2, respectively).

The lifetime average concentrations for use in cancer risk calculations based on the Andelman model are 0.000055 µg/m³ and 0.000045 µg/m³ for Property 1 and Property 2, respectively. Based on the Foster & Chrostowski model, lifetime average concentrations are 0.000022 µg/m³ and 0.000018 µg/m³ for Property 1 and Property 2, respectively. These values are summarized in **Table F-5**.

Using the Andelman model and the lower end of the range of possible K values (0.01) reported by Andelman, the estimated average concentrations for calculating hazard quotient and lifetime average concentrations for use in cancer risk calculations are somewhat higher (factor of 2-3) than the corresponding values calculated using the Foster & Chrostowski model. However, if the Andelman model with the K value of 0.01 were used for the inhalation risk assessment, the conclusions would not change. As shown in **Table 12**, the inhalation cancer risks for Property 1 (6.9×10^{-7}) and Property 2 (5.5×10^{-7}) were more than two orders of magnitude lower than the upper end of the CERCLA risk range, and an increase of 2-fold to 3-fold for those risks would not increase the total receptor risk above the upper end of the CERCLA risk range. In a similar manner, as shown in **Table 12**, the inhalation hazard quotients (higher of the values for the child and adult) at both Property 1 (adult 0.00089) and Property 2 (adult 0.00072) are orders of magnitude below the hazard index limit of 1. An increase of 2-fold to 3-fold for those inhalation hazard quotients would still result in total receptor hazard quotients that are well below 1.

Because the model for evaluating release of volatiles from potable use water to indoor air that was used in the NDMA RSL derivation is not based on chemical-specific physical and chemical characteristics and that model assumes that all “volatiles” (including the semi-volatile NDMA) can be evaluated using a “one size fits all” volatilization constant, and therefore the model predicts unrealistically high indoor air concentrations of NDMA, the chemical-specific and widely used Foster & Chrostowski shower model has been used in this risk assessment to evaluate inhalation exposures associated with potable use of groundwater.

As requested by USEPA, to complement the Foster and Chrostowski shower model calculations that were performed in this risk assessment, we have also used the MassDEP’s on-line risk assessment tool for drinking water exposures to calculate cancer risk (the MassDEP spreadsheet does not contain RfDs or RfCs for NDMA) for NDMA using the EPCs for Property 1 and Property 2 from this risk assessment. Copies of the “Risk Assessment Shortforms” are provided as **Table F-6** and **Table F-7**. The NDMA EPCs for each of the residences were entered into the MassDEP risk calculation spreadsheets. The MassDEP spreadsheet default exposure parameters, chemical and physical constants, and toxicity information were utilized in the calculations.

The inhalation cancer risks from showering that were calculated using the MassDEP spreadsheets are very similar to the cancer risks calculated in this risk assessment. For Property 1, the inhalation cancer risks for this risk assessment and for the MassDEP spreadsheet were 7×10^{-7} and 7.4×10^{-7} , respectively (See **Table 12** and **Table F-6**). For Property 2, the inhalation cancer risks for this risk assessment and for the MassDEP spreadsheet were 5.5×10^{-7} and 6×10^{-7} , respectively (see **Table 12** and **Table F-7**).

Receptor Exposure Parameters

The receptor exposure parameters for this risk assessment for the Property 1 and Property 2 wells have been selected as RME values for a resident child and adult for ingestion and dermal contact with groundwater used for potable purposes. The exposure parameter values were selected primarily from the 2014 USEPA Default Exposure Factors Tables (USEPA, 2014). These values are conservative (health protective values).

The shower exposure scenario utilizes the 2014 USEPA values that represent a weighted average 90th percentile daily time spent bathing (child) and bathing/showering (adult). These values are 0.58 hours (32.4 minutes) and 0.71 hours (42.6 minutes) for the child and adult respectively. These values were used to represent the total time spent in the bathroom per showering event (exposure occurs throughout). This risk assessment assumes that the shower is operating for half that time (17.2 minutes and 21.3 minutes, respectively). It is considered unrealistic to expect that a child would shower daily for more than 30 minutes and an adult would shower daily for more than 40 minutes. The values to evaluate the shower exposures are considered realistic and health protective.

As requested by USEPA, the Foster & Chrostowski model has also been re-run in this uncertainty analysis, with the assumption that the shower is operating for the entire time that the receptor spends in the bathroom during a showering event (adult, 0.71 hour, child, 0.58 hour). The results of those calculations are as follows: for Property 1, the NDMA shower air EPCs were 0.00203 $\mu\text{g}/\text{m}^3$ and 0.00445 $\mu\text{g}/\text{m}^3$ for the original and alternative shower operation times (see **Table D-1** and **Table F-8**); for Property 2, the NDMA shower air EPCs were 0.00165 $\mu\text{g}/\text{m}^3$ and 0.00362 $\mu\text{g}/\text{m}^3$ for the original and alternative shower operation times (see **Table D-1** and **Table F-9**). The shower air EPCs for the alternative assumption are approximately 2.2 times the original EPCs used in this assessment. The cancer risk and hazard quotient are directly related to the shower air EPCs. A 2.2-fold increase (based on the alternative values) in cancer risk and hazard quotient would not change the conclusions of the risk assessment since the inhalation cancer risks for Property 1 (7×10^{-7}) and Property 2 (5.5×10^{-7}) (see **Table 12**) were more than two orders of magnitude lower than the upper end of the CERCLA risk range and hazard quotients (higher of the values for the child and adult) at both Property 1 (adult 0.0014) and Property 2 (adult 0.0012) (see **Table 12**) are orders of magnitude below the hazard index limit of 1.

The calculation of shower EPCs for the alternative shower operation time is documented in **Tables F-8 and F-9** for Property 1 and Property 2, respectively.

Toxicity Assessment

There are varied degrees of uncertainty associated with the toxicity values utilized in the risk assessment. Risks and hazards have been calculated for NDMA, NDPrA, and nitrate. Each of these COPCs is discussed in the following text.

NDMA.

The following toxicity values were used for NDMA (and the CSF and inhalation UR were adjusted with ADAFs. Dermal CSF and RfD were equal to the corresponding oral values.

- Oral CSF: 51 per mg/kg/day – IRIS 2018 (Tier 1)
- Inhalation Unit Risk (UR): 1.4×10^{-2} per $\mu\text{g}/\text{m}^3$ – IRIS 2018 (Tier 1)
- Oral RfD: 8×10^{-6} mg/kg/day - PPRTV 2007 (Tier 2)
- Inhalation RfC: 4×10^{-2} $\mu\text{g}/\text{m}^3$ – USEPA APPENDIX PPRTV SCREEN 2007 (Tier 3)

The NDMA oral CSF and inhalation UR were obtained from a Tier I source (IRIS). These values are more comprehensive than the other values obtained from Tier 2 and 3 sources, but they are based on animal studies only (no human data sufficient to estimate these values). The oral RfD is from a USEPA PPRTV, a Tier 2 source. PPRTVs are developed when the available data are not sufficient to derive a peer-reviewed oral RfD that could meet the requirements for inclusion in the IRIS database. USEPA Appendix PPRTV Screen values (Tier 3 source) are even less comprehensive than PPRTVs. The NDMA PPRTV Appendix contains the following text concerning the NDMA inhalation RfC.

“Available inhalation data were insufficient to derive an inhalation p-RfC. ... This screening inhalation toxicity value is very uncertain because the data reported did not include weights of individual animals and were insufficiently quantitative to permit statistical tests of the weight differences or trends. However, this screening value might be supported by the similarity of the estimated equivalent inhalation daily dose at the point of departure, estimated by Klein et al. (1989, 1991) to be 0.01 mg/kg-day for reduced body weight in rats, with the oral LOAEL POD of 0.025 mg/kg-day for developmental effects in mice, used to derive the oral p-RfD”.

While the Tier 2 and Tier 3 values are more uncertain than Tier 1 values, it is not clear how this uncertainty might affect the results of the NDMA risk assessment (would the risk estimates be overestimated or underestimated and would the magnitude of the overestimate or underestimate be substantial?).

NDPrA

The following toxicity values were used for NDPrA (and the CSF and inhalation UR were adjusted with ADAFs. The dermal CSF was equal to the corresponding oral value. No RfD or RfC was available.

- Oral CSF: 7 per mg/kg/day – IRIS 2018 (Tier 1)
- Oral RfD: not available

The NDPrA oral CSF was obtained from a Tier I source (IRIS). This value is well documented, but it is based on animal studies only (no human data sufficient to estimate these values). Because there is no oral RfD the noncancer hazard associated with ingestion and dermal exposure could not be calculated (it is underestimated). However, the magnitude of this underestimation is likely minimal, since NDPrA was detected in only 1 of 31 water samples from Property 1 and only 1 of 36 samples from Property 2. Since NDPrA is not volatile, the lack of inhalation toxicity values does not introduce any important uncertainty in this scenario.

Nitrate

The nitrate RfDs are from IRIS (Tier I source) and are well documented. The sensitive endpoint is well established. These toxicity values are unlikely to underestimate the noncancer hazard of nitrate.

Other

The remaining COPCs for the two residences (calcium, magnesium, chloride, sodium, sulfate, and ammonia) were retained as COPCs because no Tapwater RSLs were available for them. However, analysis presented previously in this assessment (comparison to Health Advisories and to Recommended Dietary Intakes) concluded that the detected concentrations of these COPCs are unlikely to pose potential for adverse effects. The lack of Tapwater RSLs and RfDs for these parameters is not an uncertainty that is likely to have any substantial effect on the results and conclusions of the assessment.

DIETARY AND OTHER SOURCES OF NDMA EXPOSURE

NDMA is commonly found in foods. It can be formed during food processing, preservation and/or preparation. NDMA is formed from precursor compounds already present in, or added to, food items (WHO, 2008). Foods that NDMA is commonly found in include the following groups: 1) cured meat products (in particular, bacon) and cheeses, 2) foods preserved by smoking, such as fish and meat products, 3) foods dried by combustion gases, such as malt (including beer), low-fat dried milk products and spices, 4) pickled and salt-preserved foods, particularly pickled vegetables, and 5) foods grown or stored under humid conditions (WHO, 2008). Due to the amount of NDMA in food, drinking water likely comprises less than 10% of NDMA exposure (Health Canada, 2011; WHO, 2008). NDMA is also a disinfection by-product in drinking water. Nearly 100 million people in the United States may be served by water treatment systems with at least one detection of NDMA (USEPA, 2011). The total daily intake for a 70 kg adult from all exogenous sources (including food and drinking water) varies from 5.7 ng/kg/day to 44.4 ng/kg/day (Schäfer, Andrea I., et al., 2010). This risk assessment estimated an adult NDMA daily intake of approximately 1.9 ng/kg/day from potable use of groundwater (from ingestion, dermal contact, and inhalation during showering), assuming a 15 ng/L concentration in water. This daily intake is a very small portion of the total daily intake identified above for a 70 kg adult from all exogenous sources (including food and drinking water).

Another important source of NDMA exposure is endogenous exposure (Fristachi & Rice, 2007), which is the process of NDMA formation within the body. NDMA may be created during the digestive process, particularly in the highly acidic stomach environment, suggesting an even lower contribution of the total daily dose from drinking water (Fristachi & Rice, 2007). Due to the low proportion of total NDMA exposure from drinking water (less than 0.1% of the daily dose including exogenous and endogenous sources), controlling NDMA in drinking water is expected to have minimal impact on overall exposure (Fristachi & Rice, 2007; Hrudey, Steve E., et al., 2013).

The risk assessment has been conducted using procedures and techniques contained in Superfund risk assessment guidance that is designed to generate conservative (health protective)

https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

estimates of cancer risk and noncancer HI. The exposure parameters used in the assessment are from USEPA guidance, and are consistent with a Reasonable maximum exposure scenario. A number of the exposure assumptions are clearly conservative, and likely overestimate exposures (exposure 24 hours per day, 350 days per year, for 26 years, for example). The nature of contamination and the concentrations of COPCs in the groundwater is well characterized – it is based on multiple years of quarterly monitoring. The exposure point concentrations in groundwater of the predominant risk driver (NDMA) have been calculated in a conservative, health protective manner. There are some uncertainties in some of the toxicity values available from USEPA (Tier 2 and Tier 3 sources). There are also some uncertainties in the assessment of inhalation exposure pathway for NDMA which are discussed in detail in this assessment. Overall, the risk assessment includes a very reasonable, health-protective assessment of theoretical potable use of groundwater from the private wells at the two residences.

CONCLUSIONS

For both Property 1 and Property 2, the 26-year potable use of groundwater scenario (assuming ingestion of groundwater, dermal contact with groundwater during bathing and showering, and inhalation of volatiles during showering), the RME cumulative cancer risk (3×10^{-5}) for a theoretical resident is below 10^{-4} (the upper end of the NCP risk range of 10^{-6} to 10^{-4}) and the chronic noncancer child HI (0.09 and 0.1, respectively for the two residences) is less than 1. The risk calculation results for both residences meet the NCP and CERCLA health risk management criteria.

Olin has been providing bottled water to the two residences and we assume that the residents are using the water for its intended purpose. Separate calculations have also been performed using groundwater data for the two residences for a theoretical 26-year residential scenario in which the groundwater is used for typical household purposes except that bottled water only (not well water) is used for drinking and cooking. As expected, the RME cumulative cancer risk (8×10^{-7} and 6×10^{-7} for the two residences) is substantially lower and is actually below both the upper end and the lower end of the National Contingency Plan (NCP) risk range of 10^{-6} to 10^{-4} and the chronic noncancer child hazard index (HI) (0.002 both residences) is substantially less than 1.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Public Health Service, 1989a. "TOXICOLOGICAL PROFILE FOR N-NITROSODIMETHYLAMINE", In collaboration with U.S. Environmental Protection Agency (EPA), December.

ATSDR, 1989b. "TOXICOLOGICAL PROFILE FOR N-NITROSODI-n-PROPYLAMINE", In collaboration with U.S. Environmental Protection Agency (EPA), December.

Andelman, J.B., 1990. "Total Exposure to Volatile Organic Compounds in Potable Water", Chapter 20 in Significance and Treatment of Volatile Organic Compounds in Water Supplies. N.M. Ram, R.E. Christman, K.P. Cantor (eds.). Lewis Publishers.

Foster, S.A. and Chrostowski, P.C. 1986. "Integrated household exposure model for use of tap water contaminated with volatile organic chemicals". 79th Annual Meeting of the Air Pollution Control Association. Minneapolis, MN.

Foster, S.A. and Chrostowski, P.C. 1987. "Inhalation exposures to volatile organic contaminants in the shower". 80th Annual Meeting of the Air Pollution Control Association. New York, NY.

Fristachi, Anthony, and Glenn Rice, 2007. "Estimation of the total daily oral intake of NDMA attributable to drinking water." *Journal of water and health* 5.3: 341-355.

Health Canada (HC), 2011. "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document NNitrosodimethylamine (NDMA)".

Hrudey, Steve E., et al., 2013. "Drinking Water as a Proportion of Total Human Exposure to Volatile N-Nitrosamines." *Risk Analysis* 33.12: 2179-2208.

Schäfer, Andrea I., et al., 2010. "Micropollutants in water recycling: a case study of N-Nitrosodimethylamine (NDMA) exposure from water versus food." *Sustainability Science and Engineering* 2: 203-228.

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C. December.

USEPA, 1990. "Preamble to final rule. Federal Register, pp. 8666-8812. 40 CFR Part 300 National Oil and Hazardous Substances Pollution Contingency Plan". March 8.

USEPA, 1991a. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim." Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C., EPA/540/R-92/003, December.

USEPA, 1991b. "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions", OSWER DIRECTIVE 9355.0-30.

USEPA, 2001. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part D), Final"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C. December.

USEPA, 2002. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites" Office of Solid Waste and Emergency Response/Office of Solid Waste and Remedial Response; OSWER 9285.6-10. December.

USEPA, 2003a. "Human Health Toxicity Values in Superfund Risk Assessments" (OSWER No. 9285.7-53, December 2003).

USEPA, 2003b. "Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sulfate", Office of Water, EPA 822-R-03-007, February.

USEPA, 2003c. "Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sodium", Office of Water,

USEPA, 2004. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim)"; Office of Emergency and Remedial Response; EPA/540/R/99/005; Washington, D.C.

USEPA, 2005. "Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens"; Risk Assessment Forum; EPA/630/R-03/003F; Washington, D.C. March.

USEPA, 2007. "Provisional Peer Reviewed Toxicity Values for N-Nitrosodimethylamine (CASRN 62-75-9)", Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development, June.

USEPA, 2009a. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment, Final)"; Office of Emergency and Remedial Response; EPA/540/R/070/002; Washington, D.C.

USEPA, 2009b. "Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration", OSWER Directive 9283.1-33, June.

USEPA. 2011. "Regulatory Determinations for the Third Drinking Water Contaminant Candidate List Stakeholder Meeting". Slide presentation. Washington DC, June 16, 2011.

USEPA, 2012. "2012 Edition of the Drinking Water Standards and Health Advisories" EPA 822-S-12-001, Office of Water U.S. Environmental Protection Agency Washington, DC, April.

USEPA. 2014. OSWER Directive 9200.1-120. "Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. Attachment 1. Recommended Default Exposure Factors" (2014).

USEPA, 2015a. "OSWER Technical Guide for Assessing and Mitigating The Vapor Intrusion Pathway From Subsurface Vapor Sources To Indoor Air", OSWER Publication 9200.2-154, Office of Solid Waste and Emergency Response, June.

https://woodplc.sharepoint.com/teams/OlinWilmington/Shared Documents/General/Human Health RA Potable Wells - Revised 5-2020/Human Health RA Potable Wells Revised 5-2020/Human Health RA Private Wells_June 8_2018_05212020_clean.docx

USEPA, 2016. "Software for Calculating Upper Confidence Limits. ProUCL Version 5.1" Technical Support Center for Monitoring and Site Characterization. <https://www.epa.gov/land-research/proucl-software>.

USEPA, 2017a. "USEPA Regional Screening Levels (RSLs). Generic Tables: November 2017". URL: [<https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017>].

USEPA, 2017b. "Regional Screening Levels (RSLs) - User's Guide", (November 2017). [<https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-november-2017>]

USEPA, 2018. "Integrated Risk Information System (IRIS)"; on-line database search www.epa.gov/iris. February

U.S. Food and Drug Administration (USFDA). 2016. "Food Labeling: Revision of the Nutrition and Supplement Facts Labels, 21 CFR Part 101, Federal Register V. 81 No. 103, May 27, 2016"..

WHO, 2008. "N-Nitrosodimethylamine in drinking-water. Background document for preparation of WHO Guidelines for drinking-water quality". Geneva, World Health Organization (WHO/HSE/AMR/08.03/8)

LIST OF TABLES

Table 1	Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 1
Table 2	Selection of Chemicals of Potential Concern (RAGS D: Table 2): Groundwater – Potable Use – Residential Wells at Property 1 and Property 2
Table 3	Exposure Point Concentrations (RAGS D: Table 3): Groundwater – Potable Use – Residential Wells at Property 1 and Property 2
Table 4	Summary of Receptor Risk and Hazards for COPCs (Rags D: Table 9) – Reasonable Maximum Exposure – Property 1 – Current -Resident – ADULT – Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 5	Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure – Property 1- Current - Resident - Adult - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 6	Summary of Receptor Risks and Hazards for COPCs (RAGS D: Table 9) - Reasonable Maximum Exposure - Property 1 - Current - Resident - CHILD - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 7	Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 1 - Current - Resident - Child- Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 8	Summary of Receptor Risks and Hazards for COPCs (RAGS D: Table 9) - Reasonable Maximum Exposure – Property 2 - Current - Resident - ADULT - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 9	Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 2 - Current - Resident - Adult - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 10	Summary of Receptor Risks and Hazards for COPCs (RAGS D: Table 9) - Reasonable Maximum Exposure - Property 2 - Current - Resident - CHILD - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 11	Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 2 - Current - Resident - Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)
Table 12	Summary of Risks for Private Potable Wells - Property 1 and Property 2

LIST OF ATTACHMENTS

Attachment A	Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2
Attachment B	Comparison of Groundwater Intakes to Recommended Daily Intakes for Essential Nutrients
Attachment C	ProUCL Outputs for UCL Calculations
Attachment D	Air Concentration of VOCs While Showing – Property 1 and Property 2
Attachment E	Exposure Factors and Calculation of DAevent
Attachment F	USEPA Conditional Approval of Risk Assessment Memorandum and Tables and Figures to Support Uncertainty Analysis

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1												
			Sample ID:	Property 1 (A)	Property 1 (A)	OC-M24L54	OC-M24L54 DUP	OC-M24L54 & OC-M24L54 DUP	OC-M24L54	OC-M24L54	OC-M24L54-DUP	OC-M24L54 & OC-M24L54-DUP	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54
			Sample Date:	7/20/1995	8/13/1996	10/9/2008			3/18/2009	11/10/2009			3/30/2010	8/4/2010	10/26/2010	12/16/2010
			Sample Type:	FS	FS	FS	FD	FS & FD	FS	FS	FD	FS & FD	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units												
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L			2.6	3.1	2.85		2	1.9	1.95			
SVOC	T	100-52-7	Benzaldehyde	ug/L						4.9 U	4.5 U	4.5 U				
		65-85-0	Benzoic Acid	ug/L												
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L		0.6 U	2.1 U	2.1 U	2.1 U	3 U	1.9 U	1.8 U	1.8 U			
		105-60-2	Caprolactam	ug/L						4.9 U	4.5 U	4.5 U	4.5 U			
		84-74-2	Di-n-butylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U			
		84-66-2	Diethylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U			
		206-44-0	Fluoranthene	ug/L						1 U	0.97 U	0.91 U	0.91 U			
		78-59-1	Isophorone	ug/L						5.1 U	4.9 U	4.5 U	4.5 U			
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L												
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L					0.01 U	0.011 U	0.0098 U	0.0098 U	0.024	0.0094 U	0.0019 U	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L												
Metals	D	7440-70-2	Calcium	ug/L												
		7440-50-8	Copper	ug/L												
		7439-95-4	Magnesium	ug/L												
		7440-09-7	Potassium	ug/L												
	T	7440-23-5	Sodium	ug/L												
		7440-70-2	Calcium	ug/L		21400	46000	45000	45500	47000	47000	47000	45000	44000	44000	42000
		18540-29-9	Chromium, Hexavalent	ug/L												
		7440-47-3	Chromium	ug/L	15 U	30 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
		7440-50-8	Copper	ug/L		20 U										
		7439-89-6	Iron	ug/L		30 U										
		7439-95-4	Magnesium	ug/L		1430										
		7439-96-5	Manganese	ug/L		15										
		7440-09-7	Potassium	ug/L		500 U										
		7440-23-5	Sodium	ug/L		23200	31000	30000	30500	28000	27000	27500	27000	28000	26000	26000
Inorganics	T	7440-66-6	Zinc	ug/L		20 U										
		16887-00-6	Chloride	ug/L		36,000	33,200	72,000	71,000	71,500		72,000	72,000	72,000	76,000	76,000
		14797-55-8	Nitrate as N	ug/L				50 U	50 U	50 U		50 U	50 U	50 U	50 U	50 U
		HLA0043	Nitrogen, as Ammonia	ug/L		100 U	500 U	100 U	100 U	100 U		100 U	100 U	100 U	100 UJ	100 U
TIC	T	14808-79-8	Sulfate	ug/L		13,000	21,000	26,000	26,000	26,000		27,000	27,000	27,000	28,000	31,000
		2050-75-1	2,3-Dichloronaphthalene	ug/L												
		506-12-7	Heptadecanoic Acid	ug/L												
		57-10-3	Hexadecanoic acid	ug/L												
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L												
		HLA0197	TIC Organic Acid(s)	ug/L												
		HLA0141	TIC PAH(s)	ug/L												
		HLA0058	TIC(s) Unspecified	ug/L												
		HLA0650	Unknown Hydrocarbons	ug/L												

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1														
			Sample ID:		OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	
			Sample Date:		7/19/2011	10/12/2011	2/28/2012	5/16/2012	10/8/2012	1/15/2013	5/21/2013	9/11/2013	12/19/2013	2/25/2014	5/20/2014	9/10/2014	12/15/2014	3/24/2015	
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units															
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L															
SVOC	T	100-52-7	Benzaldehyde	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	0.13 J	4.8 UJ	4.8 U	0.95 U	0.95 U	0.95 U	
		65-85-0	Benzoic Acid	ug/L		4.8 UJ	5.1 UJ	4.7 UJ	4.7 UJ	4.8 UJ	4.8 UJ			4.8 U	4.8 U	24 UJ	24 UJ	24 UJ	
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L		1.9 UJ	2 U	1.9 U	1.9 U	4.8 UJ	1.9 U	1.9 UJ	1.9 U	0.84 J	1.9 U	4.8 U	4.8 U	4.8 U	
		105-60-2	Caprolactam	ug/L		4.8 UJ	5.1 UJ	4.7 UJ	4.7 UJ	0.96 UJ	4.8 U	4.8 UJ	4.7 UJ	4.8 UJ	4.8 U	4.8 UJ	4.8 UJ	4.8 U	
		84-74-2	Di-n-butylphthalate	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	4.8 U	4.8 U	4.8 U	4.7 U	0.43 J	1 J	4.8 U	4.8 U	4.8 U	
		84-66-2	Diethylphthalate	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	0.075 J	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U	
		206-44-0	Fluoranthene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.084 J	0.95 U	0.96 U	0.96 U	0.19 U	0.19 U	0.19 U	
		78-59-1	Isophorone	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U	
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L												4.8 U	0.95 U	0.95 U	0.95 U
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L										0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U
		62-75-9	N-Nitrosodimethylamine	ug/L	0.016	0.012	0.012	0.013 J	0.016	0.013	0.011	0.013	0.0019 U	0.01	0.011	0.012	0.022	0.01	
		85-01-8	Phenanthrene	ug/L		0.19 UJ	0.2 U	0.19 U	0.38 U	0.96 U	0.38 U	0.38 U	0.38 U	0.066 J	0.11 J	0.19 U	0.19 U	0.19 U	
Metals	D	7440-70-2	Calcium	ug/L															
		7440-50-8	Copper	ug/L															
		7439-95-4	Magnesium	ug/L															
		7440-09-7	Potassium	ug/L															
		7440-23-5	Sodium	ug/L															
	T	7440-70-2	Calcium	ug/L	44000								47000						
		18540-29-9	Chromium, Hexavalent	ug/L		1 U	1 U	1 U		5 U	1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
		7440-47-3	Chromium	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	10 U	10 U	
		7440-50-8	Copper	ug/L															
		7439-89-6	Iron	ug/L															
		7439-95-4	Magnesium	ug/L															
		7439-96-5	Manganese	ug/L															
		7440-09-7	Potassium	ug/L															
7440-23-5	Sodium	ug/L	25000	27000	28000	30000	25000	29000	28000	30000	30000	27000	28000	27000	23000	30000			
7440-66-6	Zinc	ug/L																	
Inorganics	T	16887-00-6	Chloride	ug/L	76,000	75,000	80,000	87,000	82,000 J	86,000	88,000	86,000	78,000	80,000	77,000	72,000	79,000	81,000	
		14797-55-8	Nitrate as N	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	69	50 U	31 J	110	45 J	57	50 U	50 U	
		HLA0043	Nitrogen, as Ammonia	ug/L	100 U	100 U	100 U	100 U	100 U	20 U	20	20 U	20 U	20 U	20 UJ	20 U	110	250 U	
		14808-79-8	Sulfate	ug/L	23,000	27,000	26,000	26,000	27,000	25,000	25,000	27,000	24,000	28,000	26,000	24,000	28,000	24,000	
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L															
		506-12-7	Heptadecanoic Acid	ug/L															
		57-10-3	Hexadecanoic acid	ug/L															
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L															
		HLA0197	TIC Organic Acid(s)	ug/L															
		HLA0141	TIC PAH(s)	ug/L															
		HLA0058	TIC(s) Unspecified	ug/L															
HLA0650	Unknown Hydrocarbons	ug/L														2.2 JN	4.89 JN		

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1										Property 2			
			Sample ID:	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	Property 2(A)	Property 2(A)	Property 2(A)	
			Sample Date:	6/29/2015	9/29/2015	1/27/2016	3/2/2016	6/29/2016	9/28/2016	12/6/2016	1/4/2017	3/28/2017	6/28/2017	9/27/2017	7/20/1995	8/13/1996	4/23/1998
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units													
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L													
SVOC	T	100-52-7	Benzaldehyde	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ		
		65-85-0	Benzoic Acid	ug/L	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ		2.5 J	24 UJ	24 UJ	24 UJ		
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L	1.7 J	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	1	
		105-60-2	Caprolactam	ug/L	4.8 UJ	4.8 U	0.25 J	4.8 UJ	0.25 J	4.8 UJ		4.8 UJ	0.3 J	4.8 U	4.8 UJ		
		84-74-2	Di-n-butylphthalate	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ		
		84-66-2	Diethylphthalate	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		3.1 U	1.9 U	1.9 U	1.9 UJ		
		206-44-0	Fluoranthene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		
		78-59-1	Isophorone	ug/L	0.95 U	0.95 U	0.95 U	0.95 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ		
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L	0.95 U	0.95 U	0.95 U	0.25 U									
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U		0.0019 U	0.0019 U	0.0019 UJ		
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U									
		62-75-9	N-Nitrosodimethylamine	ug/L	0.0094	0.012	0.014 J	0.012	0.024	0.0019 U	0.0019 U		0.016	0.011	0.015 J		
		85-01-8	Phenanthrene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U	
Metals	D	7440-70-2	Calcium	ug/L													
		7440-50-8	Copper	ug/L													
		7439-95-4	Magnesium	ug/L													
		7440-09-7	Potassium	ug/L													
	T	7440-23-5	Sodium	ug/L													
		7440-70-2	Calcium	ug/L												52500	22400
		18540-29-9	Chromium, Hexavalent	ug/L	5 U	5 U	10 U	10 U	10 U	6 J		10 U		10 U	10 U		
		7440-47-3	Chromium	ug/L	2.2 J	0.63 J	0.62 J	0.6 J	10 U	10 U		0.71 J		10 U	10 U	15 U	30 U
		7440-50-8	Copper	ug/L												36	
		7439-89-6	Iron	ug/L												41	52
		7439-95-4	Magnesium	ug/L												5600	1970
		7439-96-5	Manganese	ug/L												10 U	10 U
		7440-09-7	Potassium	ug/L												2620	2600
7440-23-5	Sodium	ug/L	29000	31000	31000	29000	30000	30000		29000	28000	29000	29000	38700	36600		
7440-66-6	Zinc	ug/L												30			
Inorganics	T	16887-00-6	Chloride	ug/L	77,000	81,000	80,000	72,000	82,000	81,000		82,000		84,000	89,000	89,000	59,600
		14797-55-8	Nitrate as N	ug/L	52 J	26 J	29 J	39 J	22 J	44 J		50 U		24 J	40 J	50 U	
		HLA0043	Nitrogen, as Ammonia	ug/L	250 U	250 U	160 J	250 U	200 U	230 U		130 J		220 U	280 U	130 J	
		14808-79-8	Sulfate	ug/L	24,000	24,000	25,000	22,000	24,000	25,000		22,000		35,000	26,000	29,000	17,000
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L													
		506-12-7	Heptadecanoic Acid	ug/L													
		57-10-3	Hexadecanoic acid	ug/L													
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L													
		HLA0197	TIC Organic Acid(s)	ug/L			1.3 JN										
		HLA0141	TIC PAH(s)	ug/L													
		HLA0058	TIC(s) Unspecified	ug/L	6.75 JN	3.26 JN	6.39 JN	0.38 JN				2.02 JN	3.13 JN	4.07 JN			
	HLA0650	Unknown Hydrocarbons	ug/L								1.65 JN						

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 2												
				Property 2(A)	Property 2 - 24/94	Property 2 - 24/94 Dup	Property 2 - 24/94 & Property 2 - 24/94 Dup	Property 2 - 24/94	Property 2 - 24/94 & Property 2 - 24/94 Dup	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94
				9/14/1999	2/2/2005					12/5/2008	3/18/2009	11/10/2009	7/8/2010	8/4/2010	9/29/2010	10/26/2010
			Sample Type:	FS	FS	FD	FS & FD	FS (8270 only)	Resolved (8270 all (1))	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units												
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L		1 U	1 U	1 U		0.5 U		1 U				
SVOC	T	100-52-7	Benzaldehyde	ug/L								4.5 U				
		65-85-0	Benzoic Acid	ug/L				50 U								
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L				10 U		2 U	2.9 U	1.8 U				
		105-60-2	Caprolactam	ug/L								4.5 U				
		84-74-2	Di-n-butylphthalate	ug/L				10 U			5.1 U	4.5 U				
		84-66-2	Diethylphthalate	ug/L				10 U			5.1 U	4.5 U				
		206-44-0	Fluoranthene	ug/L		1 U		5 U	1 U		1 U	0.91 U				
		78-59-1	Isophorone	ug/L				10 U			5.1 U	4.5 U				
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L				10 U								
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L							0.01 U	0.01 U	0.0096 UJ	0.0094 U	0.0089 U	0.0019 U
Metals	D	621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L												
		62-75-9	N-Nitrosodimethylamine	ug/L		0.002 UJ	0.0025 J	0.0025 J								
		85-01-8	Phenanthrene	ug/L		1 U		5 U	1 U	0.014	0.002 U	0.0063	0.0019 UJ	0.031	0.017	0.0041 J
	T	7440-70-2	Calcium	ug/L		24000	23000	23500								
		7440-50-8	Copper	ug/L		40	38	39								
		7439-95-4	Magnesium	ug/L		1500	1400	1450								
		7440-09-7	Potassium	ug/L		2600 J	2400 J	2500 J								
		7440-23-5	Sodium	ug/L		26000	26000	26000								
		7440-70-2	Calcium	ug/L	55000					29000		30000	35000 J	36000	43000	44000
		18540-29-9	Chromium, Hexavalent	ug/L												
		7440-47-3	Chromium	ug/L	10 U					5 U	5 U	5 U	5 U	5 U	5 U	5 U
		7440-50-8	Copper	ug/L												
		7439-89-6	Iron	ug/L	50 U											
Inorganics	T	7439-95-4	Magnesium	ug/L	5300											
		7439-96-5	Manganese	ug/L	10 U											
		7440-09-7	Potassium	ug/L	2600											
		7440-23-5	Sodium	ug/L	32000					40000		26000	18000	18000	23000	20000
		7440-66-6	Zinc	ug/L												
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L												
		506-12-7	Heptadecanoic Acid	ug/L												
		57-10-3	Hexadecanoic acid	ug/L												
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L												
		HLA0197	TIC Organic Acid(s)	ug/L												
		HLA0141	TIC PAH(s)	ug/L												
		HLA0058	TIC(s) Unspecified	ug/L												
		HLA0650	Unknown Hydrocarbons	ug/L												

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2													
			Sample ID:		OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	
			Sample Date:		12/17/2010	3/30/2011	7/12/2011	10/12/2011	2/28/2012	5/16/2012	10/9/2012	1/15/2013	3/18/2013	5/21/2013	9/11/2013	12/18/2013	2/18/2014	5/20/2014
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units														
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L														
SVOC	T	100-52-7	Benzaldehyde	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	0.31 J	4.8 UJ	4.8 U
		65-85-0	Benzoic Acid	ug/L				4.9 UJ	5.1 UJ	4.7 UJ	4.8 UJ	4.8 UJ		4.9 UJ				4.8 U
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L				2 UJ	1.9 U	1.9 U	1.9 U	4.8 UJ		1.9 U	2 UJ	1.9 U	1.9 U	1.9 U
		105-60-2	Caprolactam	ug/L				4.9 UJ	4.8 UJ		4.8 UJ	0.33 J		4.9 U	4.9 UJ	4.8 UJ	4.8 UJ	4.8 U
		84-74-2	Di-n-butylphthalate	ug/L				4.9 UJ	5.1 U	4.7 U	4.8 U	4.8 U		4.9 U	4.9 U	4.8 U	0.88 J	0.57 J
		84-66-2	Diethylphthalate	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		0.065 J	4.9 U	4.8 U	4.8 U	4.8 U
		206-44-0	Fluoranthene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 UJ	0.96 U
		78-59-1	Isophorone	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L														4.8 U
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U	0.0034 U	0.0019 UJ	0.0019 U	0.0019 U	0.0019 U	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L														0.0019 U
		62-75-9	N-Nitrosodimethylamine	ug/L	0.013	0.019 U	0.0019 U	0.004	0.0066	0.0069 J	0.033	0.0019 U	0.0021 U	0.0018 J	0.0019 U	0.0019 U	0.0021 U	0.00051 J
		85-01-8	Phenanthrene	ug/L				0.2 UJ	0.19 U	0.19 U	0.38 U	0.96 U		0.39 U	0.39 U	0.38 U	0.088 J	0.39 U
Metals	D	7440-70-2	Calcium	ug/L														
		7440-50-8	Copper	ug/L														
		7439-95-4	Magnesium	ug/L														
		7440-09-7	Potassium	ug/L														
		7440-23-5	Sodium	ug/L														
	T	7440-70-2	Calcium	ug/L	19000	20000	37000									67000		
		18540-29-9	Chromium, Hexavalent	ug/L				0.73 J	1 U	1 U	1 J	5 U		1 U	5 U	5 U	5 U	5 U
		7440-47-3	Chromium	ug/L	5 U	5 U	0.67 J	5 U	5 U	5 U	5 U	5 U		5 U	5 U	5 U	5 U	5 U
		7440-50-8	Copper	ug/L														
		7439-89-6	Iron	ug/L														
		7439-95-4	Magnesium	ug/L														
		7439-96-5	Manganese	ug/L														
		7440-09-7	Potassium	ug/L														
7440-23-5	Sodium	ug/L	23000	23000	49000	64000	29000	29000	30000	27000		76000	43000	37000	150000	76000		
7440-66-6	Zinc	ug/L																
Inorganics	T	16887-00-6	Chloride	ug/L	43,000	47,000	120,000	200,000	38,000	44,000	49,000 J	53,000		190,000	120,000	130,000	320,000	170,000
		14797-55-8	Nitrate as N	ug/L	1800	1700	1500	1300	1900	2000	1300	2200		3900	550	260	4800	2200
		HLA0043	Nitrogen, as Ammonia	ug/L	100 UJ	100 U	100 U	100 U	100 U	100 U	150	20 U		18 J	20 U	20 U	12 J	20 U
		14808-79-8	Sulfate	ug/L	17,000	13,000	14,000	15,000	18,000	18,000	23,000	20,000		14,000	24,000	25,000	14,000	18,000
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L														
		506-12-7	Heptadecanoic Acid	ug/L														
		57-10-3	Hexadecanoic acid	ug/L														
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L														
		HLA0197	TIC Organic Acid(s)	ug/L														
		HLA0141	TIC PAH(s)	ug/L														
		HLA0058	TIC(s) Unspecified	ug/L														
HLA0650	Unknown Hydrocarbons	ug/L																

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2														
			Sample ID:		OC-24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24 L94	OC-M24L94		
			Sample Date:		9/10/2014	12/9/2014	3/25/2015	6/29/2015	9/29/2015	1/27/2016	3/23/2016	6/29/2016	9/29/2016	12/6/2016	1/4/2017	3/29/2017	6/22/2017	8/3/2017	
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units															
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L															
SVOC	T	100-52-7	Benzaldehyde	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.95 U	1.9 U		1.9 U	1.9 UJ	1.9 U		
		65-85-0	Benzoic Acid	ug/L		24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ		
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 UJ	4.8 U	
		105-60-2	Caprolactam	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 UJ	4.8 UJ	0.22 J	4.8 U	4.8 U	4.8 UJ	4.8 UJ	4.8 UJ	0.32 J	
		84-74-2	Di-n-butylphthalate	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 UJ	4.8 UJ	
		84-66-2	Diethylphthalate	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 UJ	1.9 U	
		206-44-0	Fluoranthene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 UJ	0.19 U	
		78-59-1	Isophorone	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.36 J	0.95 U	0.96 U	0.95 U		0.95 U	0.96 UJ	0.95 U	
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U									
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0029 J	0.0019 UJ	0.0019 U	0.0019 U	0.0019 U		0.0019 U	0.0019 UJ	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U									
		62-75-9	N-Nitrosodimethylamine	ug/L	0.0089	0.0051	0.001 J	0.013	0.0014 J	0.0046 J	0.00087 J	0.0055	0.0019 U	0.0019 U		0.0019 U		0.056	
		85-01-8	Phenanthrene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U		
Metals	D	7440-70-2	Calcium	ug/L															
		7440-50-8	Copper	ug/L															
		7439-95-4	Magnesium	ug/L															
		7440-09-7	Potassium	ug/L															
	T	7440-23-5	Sodium	ug/L															
		7440-70-2	Calcium	ug/L															
		18540-29-9	Chromium, Hexavalent	ug/L	5 U	5 U	5 U	5 U	5 U	10 U	10 U	10 U	10 U	10 U		10 U	10 U		
		7440-47-3	Chromium	ug/L	5 U	0.62 J	10 U	0.99 J	1.1 J	10 U	10 U	0.78 J	0.86 J	0.78 J		10 U	10 U		
		7440-50-8	Copper	ug/L															
		7439-89-6	Iron	ug/L															
		7439-95-4	Magnesium	ug/L															
		7439-96-5	Manganese	ug/L															
		7440-09-7	Potassium	ug/L															
7440-23-5	Sodium	ug/L	61000	120000	59000	55000	54000	49000	45000	59000	35000	26000		33000	31000				
7440-66-6	Zinc	ug/L																	
Inorganics	T	16887-00-6	Chloride	ug/L	180,000	280,000	110,000	92,000	140,000	84,000	82,000	110,000	120,000	110,000		100,000	89,000		
		14797-55-8	Nitrate as N	ug/L	1100	2000	2200	1300 J	650	2400	2200	2500	360	230		740	1300		
		HLA0043	Nitrogen, as Ammonia	ug/L	20 U	130	250 U	250 U	250 U	250 U	250 U	200 U	220 U	110 J		330 U	350 U		
		14808-79-8	Sulfate	ug/L	20,000	18,000	18,000	18,000	22,000	18,000	18,000	20,000	24,000	17,000		22,000	21,000		
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L							0.78 JN								
		506-12-7	Heptadecanoic Acid	ug/L			0.76 JN												
		57-10-3	Hexadecanoic acid	ug/L			0.94 JN												
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L															
		HLA0197	TIC Organic Acid(s)	ug/L						0.84 JN					2 JN				
		HLA0141	TIC PAH(s)	ug/L			0.81 JN												
		HLA0058	TIC(s) Unspecified	ug/L			2.5 JN	2.91 JN	1.19 JN	3.6 JN	2.19 JN	1.7 JN		19.3 JN					
HLA0650	Unknown Hydrocarbons	ug/L			0.95 JN				4.26 JN		0.51 JN			1.1 JN					

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 2	
			Sample ID:	OC-M24L94	OC-M24L94
			Sample Date:	8/24/2017	9/28/2017
			Sample Type:	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units	
VOC	T	1634-04-4	Methyl Tertbutyl Ether	ug/L	
SVOC	T	100-52-7	Benzaldehyde	ug/L	1.9 U
		65-85-0	Benzoic Acid	ug/L	24 UJ
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L	4.8 U
		105-60-2	Caprolactam	ug/L	4.8 UJ
		84-74-2	Di-n-butylphthalate	ug/L	4.8 U
		84-66-2	Diethylphthalate	ug/L	1.9 U
		206-44-0	Fluoranthene	ug/L	0.19 U
		78-59-1	Isophorone	ug/L	0.95 U
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L	
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L	0.0019 U
		62-75-9	N-Nitrosodimethylamine	ug/L	0.0019 U
		85-01-8	Phenanthrene	ug/L	0.19 U
Metals	D	7440-70-2	Calcium	ug/L	
		7440-50-8	Copper	ug/L	
		7439-95-4	Magnesium	ug/L	
		7440-09-7	Potassium	ug/L	
		7440-23-5	Sodium	ug/L	
	T	7440-70-2	Calcium	ug/L	
		18540-29-9	Chromium, Hexavalent	ug/L	10 U
		7440-47-3	Chromium	ug/L	10 U
		7440-50-8	Copper	ug/L	
		7439-89-6	Iron	ug/L	
		7439-95-4	Magnesium	ug/L	
		7439-96-5	Manganese	ug/L	
		7440-09-7	Potassium	ug/L	
		7440-23-5	Sodium	ug/L	27000
		7440-66-6	Zinc	ug/L	
Inorganics	T	16887-00-6	Chloride	ug/L	130,000
		14797-55-8	Nitrate as N	ug/L	230
		HLA0043	Nitrogen, as Ammonia	ug/L	130 J
		14808-79-8	Sulfate	ug/L	24,000
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L	
		506-12-7	Heptadecanoic Acid	ug/L	
		57-10-3	Hexadecanoic acid	ug/L	
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L	
		HLA0197	TIC Organic Acid(s)	ug/L	
		HLA0141	TIC PAH(s)	ug/L	
		HLA0058	TIC(s) Unspecified	ug/L	
		HLA0650	Unknown Hydrocarbons	ug/L	

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
Only analytical parameters detected in at least 1 sample from Property 1 and Property 2 wells are listed in this table.

Prepared by: JPK 2/27/2018
Checked by: LCG 2/27/2018

ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved

- (1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
- (2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Table 2
Selection of Chemicals of Potential Concern (RAGS D: Table 2): Groundwater - Potable Use - Residential Wells at Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

Samples collected from the below locations from January 1995 through November 8th 2017 are included in this table.

Locations within the Aberjona Watershed include:

M-24/L-54, M-24/L-94

Medium: Groundwater in Private Wells

Exposure Medium: Drinking Water, Shower Water, and Shower Air

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1) (ug/L)	Maximum Concentration (Qualifier) (1) (ug/L)	Sample and Date of Maximum Concentration	Frequency of Detection (6)	Range of Sample Quantitation Limits for Non-Detects (7) (ug/L)	Concentration Used for Screening (2) (ug/L)	Background Value (3) (ug/L)	Screening Level (SL) and Toxicity Value Basis (N/C) (4) (ug/L)	Number of Concentrations Above SL	Potential ARAR/TBC Value/Source (8) (ug/L)	Retain as COPC? (Y/N)	Rationale for Selection or Deletion (5)	
Property 1, M-24/L-54, Aberjona Watershed															
Volatile Organic Compounds															
M-24/L-54	Property 1	1634-04-4	Methyl Tertbutyl Ether	2.0	2.9	OC-M24L54_10/9/2008	2 / 2	-	2.9	NA	14 (c*) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
Semi-Volatile Organic Compounds															
M-24/L-54	Property 1	100-52-7	Benzaldehyde	0.13 (J)	0.13 (J)	OC-M24L54_12/19/2013	1 / 24	0.25 - 5.1	0.13	NA	19 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-54	Property 1	65-85-0	Benzoic Acid	2.5 (J)	2.5 (J)	OC-M24L54_1/4/2017	1 / 19	4.7 - 24	2.5	NA	7500 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-54	Property 1	117-81-7	Bis(2-Ethylhexyl)phthalate	0.84 (J)	1.7 (J)	OC-M24L54_6/29/2015	2 / 27	0.6 - 4.8	1.7	NA	5.6 (c**) - USEPA Tapwater RSL	0	6	N	Max ≤ SL
M-24/L-54	Property 1	105-60-2	Caprolactam	0.25 (J)	0.30 (J)	OC-M24L54_3/28/2017	3 / 23	0.96 - 5.1	0.30	NA	990 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-54	Property 1	84-66-2	Diethylphthalate	0.075 (J)	0.075 (J)	OC-M24L54_9/11/2013	1 / 25	0.96 - 5.1	0.075	NA	1500 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-54	Property 1	84-74-2	Di-n-butylphthalate	0.43 (J)	1.0 (J)	OC-M24L54_5/20/2014	2 / 25	4.5 - 5.1	1.0	NA	90 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-54	Property 1	206-44-0	Fluoranthene	0.084 (J)	0.084 (J)	OC-M24L54_9/11/2013	1 / 25	0.19 - 1	0.084	NA	80.2 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-54	Property 1	62-75-9	N-Nitrosodimethylamine	0.0091	0.024	OC-M24L54_6/29/2016	29 / 32	0.0019 - 0.0019	0.024	NA	0.00011 (c*) - USEPA Tapwater RSL	29	NA	Y	Max > SL
M-24/L-54	Property 1	621-64-7	N-Nitrosodi-n-propylamine	0.024	0.024	OC-M24L54_3/30/2010	1 / 31	0.0019 - 0.01	0.024	NA	0.011 (c) - USEPA Tapwater RSL	1	NA	Y	Max > SL
M-24/L-54	Property 1	85-01-8	Phenanthrene	0.066 (J)	0.11 (J)	OC-M24L54_5/20/2014	2 / 26	0.1 - 0.96	0.11	NA	177 (n) - USEPA Tapwater RSL (Anthracene)	0	NA	N	Max ≤ SL
Metals, Total															
M-24/L-54	Property 1	7440-70-2	Calcium	21400	47000	OC-M24L54_11/10/2009, OC-M24L54_12/19/2013	10 / 10	-	47000	NA	--	NA	NA	Y	No SL
M-24/L-54	Property 1	7440-47-3	Chromium	0.56 (J)	2.2 (J)	OC-M24L54_6/29/2015	6 / 33	5 - 30	2.2	NA	2200 (c) - USEPA Tapwater RSL (Chromium III)	0	100	N	Max ≤ SL
M-24/L-54	Property 1	18540-29-9	Chromium, Hexavalent	6.0 (J)	6.0 (J)	OC-M24L54_9/28/2016	1 / 22	1 - 10	6.0	NA	0.035 (c) - USEPA Tapwater RSL	1	NA	N	False positive (10)
M-24/L-54	Property 1	7439-95-4	Magnesium	1430	1430	Property 1(A)_8/13/1996	1 / 1	-	1430	NA	--	NA	NA	Y	No SL
M-24/L-54	Property 1	7439-96-5	Manganese	15	15	Property 1(A)_8/13/1996	1 / 1	-	15	NA	43 (n) - USEPA Tapwater RSL (Manganese (Non-diet))	0	50	N	Max ≤ SL
M-24/L-54	Property 1	7440-23-5	Sodium	23000	31000	OC-M24L54_1/27/2016, OC-M24L54_9/29/2015	32 / 32	-	31000	NA	--	NA	NA	Y	No SL
Inorganics, Total															
M-24/L-54	Property 1	16887-00-6	Chloride	33200	89000	OC-M24L54_6/28/2017, OC-M24L54_9/27/2017	33 / 33	-	89000	NA	--	NA	250000	Y	No SL
M-24/L-54	Property 1	14797-55-8	Nitrate as N	22 (J)	110	OC-M24L54_2/25/2014	13 / 32	50 - 100	110	NA	3200 (n) - USEPA Tapwater RSL	0	10000	N	Max ≤ SL
M-24/L-54	Property 1	HLA0043	Nitrogen, as Ammonia	20	160 (J)	OC-M24L54_1/27/2016	5 / 33	20 - 500	160	NA	--	NA	NA	Y	No SL
M-24/L-54	Property 1	14808-79-8	Sulfate	13000	35000	OC-M24L54_3/28/2017	33 / 33	-	35000	NA	--	NA	250000	Y	No SL
TIC (9)															
M-24/L-54	Property 1	HLA0197	TIC Organic Acid(s)	1.3 (JN)	1.3 (JN)	OC-M24L54_1/27/2016	1 / 1	-	1.3	NA	--	NA	NA	Y	No SL
M-24/L-54	Property 1	HLA0058	TIC(s) Unspecified	0.38 (JN)	2.2 (JN)	OC-M24L54_12/15/2014	8 / 8	-	2.2	NA	--	NA	NA	Y	No SL
M-24/L-54	Property 1	HLA0650	Unknown Hydrocarbons	0.83 (JN)	1.2 (JN)	OC-M24L54_3/24/2015	2 / 2	-	1.2	NA	--	NA	NA	Y	No SL
Property 2, M-24/L-94, Aberjona Watershed															
Semi-Volatile Organic Compounds															
M-24/L-94	Property 2	100-52-7	Benzaldehyde	0.31 (J)	0.31 (J)	OC-M24L94_12/18/2013	1 / 24	0.95 - 4.9	0.31	NA	19 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	117-81-7	Bis(2-Ethylhexyl)phthalate	1.0	1.0	Property 2(A)_8/13/1996	1 / 28	1.8 - 10	1.0	NA	5.6 (c**) - USEPA Tapwater RSL	0	6	N	Max ≤ SL
M-24/L-94	Property 2	105-60-2	Caprolactam	0.22 (J)	0.33 (J)	OC-M24L94_1/15/2013	3 / 23	4.5 - 4.9	0.33	NA	990 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL

Table 2
Selection of Chemicals of Potential Concern (RAGS D: Table 2): Groundwater - Potable Use - Residential Wells at Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

Samples collected from the below locations from January 1995 through November 8th 2017 are included in this table.

Locations within the Aberjona Watershed include:

M-24/L-54, M-24/L-94

Medium: Groundwater in Private Wells

Exposure Medium: Drinking Water, Shower Water, and Shower Air

Exposure Point		CAS Number	Chemical	Minimum Concentration (Qualifier) (1) (ug/L)	Maximum Concentration (Qualifier) (1) (ug/L)	Sample and Date of Maximum Concentration	Frequency of Detection (6)	Range of Sample Quantitation Limits for Non-Detects (7) (ug/L)	Concentration Used for Screening (2) (ug/L)	Background Value (3) (ug/L)	Screening Level (SL) and Toxicity Value Basis (N/C) (4) (ug/L)	Number of Concentrations Above SL	Potential ARAR/TBC Value/Source (8) (ug/L)	Retain as COPC? (Y/N)	Rationale for Selection or Deletion (5)
M-24/L-94	Property 2	84-66-2	Diethylphthalate	0.065 (J)	0.065 (J)	OC-M24L94_5/21/2013	1 / 26	0.96 - 10	0.065	NA	1500 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	84-74-2	Di-n-butylphthalate	0.57 (J)	0.88 (J)	OC-M24L94_2/18/2014	2 / 26	4.5 - 10	0.88	NA	90 (n) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	78-59-1	Isophorone	0.36 (J)	0.36 (J)	OC-M24L94_3/23/2016	1 / 26	0.95 - 10	0.36	NA	78 (c**) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	62-75-9	N-Nitrosodimethylamine	0.00051 (J)	0.056	OC-M24L94_8/3/2017	23 / 36	0.0019 - 0.019	0.056	NA	0.00011 (c*) - USEPA Tapwater RSL	23	NA	Y	Max > SL
M-24/L-94	Property 2	621-64-7	N-Nitrosodi-n-propylamine	0.0029 (J)	0.0029 (J)	OC-M24L94_3/23/2016	1 / 36	0.0019 - 10	0.0029	NA	0.011 (c) - USEPA Tapwater RSL	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	85-01-8	Phenanthrene	0.088 (J)	0.088 (J)	OC-M24L94_2/18/2014	1 / 27	0.1 - 1	0.088	NA	177 (n) - USEPA Tapwater RSL (Anthracene)	0	NA	N	Max ≤ SL
Metals, Dissolved															
M-24/L-94	Property 2	7440-70-2	Calcium	23500	23500	Property 2 - 24/94_2/2/2005	1 / 1	-	23500	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-50-8	Copper	39	39	Property 2 - 24/94_2/2/2005	1 / 1	-	39	NA	80 (n) - USEPA Tapwater RSL	0	1300	N	Max ≤ SL
M-24/L-94	Property 2	7439-95-4	Magnesium	1450	1450	Property 2 - 24/94_2/2/2005	1 / 1	-	1450	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-09-7	Potassium	2500 (J)	2500 (J)	Property 2 - 24/94_2/2/2005	1 / 1	-	2500	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-23-5	Sodium	26000	26000	Property 2 - 24/94_2/2/2005	1 / 1	-	26000	NA	--	NA	NA	Y	No SL
Metals, Total															
M-24/L-94	Property 2	7440-70-2	Calcium	19000	67000	OC-M24L94_12/18/2013	13 / 13	-	67000	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-47-3	Chromium	0.62 (J)	1.1 (J)	OC-M24L94_9/29/2015	7 / 36	5 - 30	1.1	NA	2200 (c) - USEPA Tapwater RSL (Chromium III)	0	100	N	Max ≤ SL
M-24/L-94	Property 2	18540-29-9	Chromium, Hexavalent	0.73 (J)	1.0 (J)	OC-M24L94_10/9/2012	2 / 23	1 - 10	1.0	NA	0.035 (c) - USEPA Tapwater RSL	2	NA	N	False positive (10)
M-24/L-94	Property 2	7440-50-8	Copper	36	36	Property 2(A)_8/13/1996	1 / 1	-	36	NA	80 (n) - USEPA Tapwater RSL	0	1300	N	Max ≤ SL
M-24/L-94	Property 2	7439-89-6	Iron	41	52	Property 2(A)_4/23/1998	2 / 3	50 - 50	52	NA	1400 (n) - USEPA Tapwater RSL	0	300	N	Max ≤ SL
M-24/L-94	Property 2	7439-95-4	Magnesium	1970	5600	Property 2(A)_8/13/1996	3 / 3	-	5600	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-09-7	Potassium	2600	2620	Property 2(A)_8/13/1996	3 / 3	-	2620	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-23-5	Sodium	18000	150000	OC-M24L94_2/18/2014	35 / 35	-	150000	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	7440-66-6	Zinc	30	30	Property 2(A)_8/13/1996	1 / 1	-	30	NA	600 (n) - USEPA Tapwater RSL	0	5000	N	Max ≤ SL
Inorganics, Total															
M-24/L-94	Property 2	16887-00-6	Chloride	2500	320000	OC-M24L94_2/18/2014	37 / 37	-	320000	NA	--	NA	250000	Y	No SL
M-24/L-94	Property 2	14797-55-8	Nitrate as N	230	4800	OC-M24L94_2/18/2014	35 / 35	-	4800	NA	3200 (n) - USEPA Tapwater RSL	3	10000	Y	Max > SL
M-24/L-94	Property 2	HLA0043	Nitrogen, as Ammonia	12 (J)	660	Property 2(A)_4/23/1998	9 / 37	20 - 500	660	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	14808-79-8	Sulfate	13000	29000	OC-M24L94_10/26/2010, OC-M24L94_9/29/2010	37 / 37	-	29000	NA	--	NA	250000	Y	No SL
TIC (9)															
M-24/L-94	Property 2	2050-75-1	2,3-Dichloronaphthalene	0.78 (JN)	0.78 (JN)	OC-M24L94_3/23/2016	1 / 1	-	0.78	NA	75 (n) - USEPA Tapwater RSL (Chloronaphthalene, Beta-)	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	506-12-7	Heptadecanoic Acid	0.76 (JN)	0.76 (JN)	OC-M24L94_3/25/2015	1 / 1	-	0.76	NA	4000 (n) - USEPA Tapwater RSL (Hexanedioic Acid)	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	57-10-3	Hexadecanoic acid	0.94 (JN)	0.94 (JN)	OC-M24L94_3/25/2015	1 / 1	-	0.94	NA	4000 (n) - USEPA Tapwater RSL (Hexanedioic Acid)	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	4237-44-9	Phenol, 2-(1-phenylethyl)-	2.0 (JN)	2.0 (JN)	OC-M24L94_1/4/2017	1 / 1	-	2.0	NA	30 (c) - USEPA Tapwater RSL (2-Phenylphenol)	0	NA	N	Max ≤ SL
M-24/L-94	Property 2	HLA0197	TIC Organic Acid(s)	0.84 (JN)	0.84 (JN)	OC-M24L94_1/27/2016	1 / 1	-	0.84	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	HLA0141	TIC PAH(s)	0.81 (JN)	0.81 (JN)	OC-M24L94_3/25/2015	1 / 1	-	0.81	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	HLA0058	TIC(s) Unspecified	0.60 (JN)	4.8 (JN)	OC-M24L94_1/4/2017	7 / 7	-	4.8	NA	--	NA	NA	Y	No SL
M-24/L-94	Property 2	HLA0650	Unknown Hydrocarbons	0.51 (JN)	1.1 (JN)	OC-M24L94_3/29/2017	4 / 4	-	1.1	NA	--	NA	NA	Y	No SL

Table 2
Selection of Chemicals of Potential Concern (RAGS D: Table 2): Groundwater - Potable Use - Residential Wells at Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

Samples collected from the below locations from January 1995 through November 8th 2017 are included in this table.
Locations within the Aberjona Watershed include: M-24/L-54, M-24/L-94

Medium: Groundwater in Private Wells Exposure Medium: Drinking Water, Shower Water, and Shower Air

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1) (ug/L)	Maximum Concentration (Qualifier) (1) (ug/L)	Sample and Date of Maximum Concentration	Frequency of Detection (6)	Range of Sample Quantitation Limits for Non-Detects (7) (ug/L)	Concentration Used for Screening (2) (ug/L)	Background Value (3) (ug/L)	Screening Level (SL) and Toxicity Value Basis (N/C) (4) (ug/L)	Number of Concentrations Above SL	Potential ARAR/TBC Value/Source (8) (ug/L)	Retain as COPC? (Y/N)	Rationale for Selection or Deletion (5)
----------------	------------	----------	--	--	--	----------------------------	--	---	-----------------------------	--	-----------------------------------	--	-----------------------	---

Notes:

ARAR/TBC - Applicable or Relevant and Appropriate Requirements/To Be Considered.

COPC - Chemicals of Potential Concern.

NA - Not Available.

SL - Screening Level

TIC - Tentatively Identified Compound

USEPA TT - Lead is regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. The lead action level is 15 ug/L.

USEPA Tapwater RSL - United States Environmental Protection Agency Regional Screening Levels for Tapwater (USEPA, 2017).

USEPA MCL - United States Protection Agency Maximum Contamination Level (USEPA, 2017)

USEPA Secondary Drinking Water Standards - Secondary Drinking Water Regulations: Guidance for Nuisance Chemicals. Table of Secondary Drinking Water Standards. (USEPA, 2017).

(1) Data selected from samples of private wells located in the Aberjona and Ipswich Watershed, collected from January 1995 to November 8th 2017.

J - The detected concentration is estimated.

JN - The analysis indicates that the analyte is "tentatively identified" and the associated numerical value may not be consistent with the amount actually present in the environmental sample.

(2) The maximum detected concentration has been used for screening purposes.

(3) No site-specific background values were identified.

(4) This column shows the final selected value, the toxicity basis for RSLs, and the source.

If a surrogate was selected based on structural or chemical similarity, this is also noted for chemicals without screening levels.

Selected Screening Toxicity Values for groundwater are the lower of concentrations associated with:

a) USEPA RSLs for Tapwater (Target Hazard Quotient of 0.1 and an Excess Lifetime Cancer Risk of 1x10⁻⁶ (USEPA, 2017)),

b) USEPA MCL and USEPA Secondary Drinking Water Regulations (USEPA, 2017).

The RSL values are calculated based on a non-cancer or a cancer target. Other calculation notes are also included. This is provided for the RSL values and defined as:

n - Non-cancer target HQ of 0.1.

c - Cancer target ELCR of 1x10⁻⁶.

c* - Cancer target ELCR of 1x10⁻⁶. Note: the RSL calculated using a non-carcinogenic endpoint is < 100 times greater this carcinogenic endpoint.

c** - Cancer target ELCR of 1x10⁻⁶. Note: the RSL calculated using a non-carcinogenic endpoint is < 10 times greater than this carcinogenic endpoint.

(5) The codes used for the "Rationale for Selection or Deletion" are as follows:

Max > SL - Maximum detected concentration is greater than the selected screening toxicity value.

Max ≤ SL - Maximum detected concentration is less than or equal to the selected screening toxicity value.

No SL - No screening level available.

(6) Number of samples detected / Number of samples analyzed. Compounds never detected are not included in the COPC selection process.

(7) Sample Quantitation Limits are only shown for non-detects. If the Frequency of Detection is 100%, no Sample Quantitation Limits are shown, except in cases where a detected value represents the resolution of a duplicate pair analysis where one result was a detect and the other was not detected. In this case, the Sample Quantitation Limit for the resolved non-detect is shown.

(8) The Maximum Contamination Level (MCL) is a TBC for this site.

(9) Although TICs were carried through the COPC selection process, they have not been carried through the full risk calculations and are discussed further in the text as a potential uncertainty.

(10) Geochemistry information indicates that groundwater conditions are inconsistent with the presence of hexavalent chromium. The reported detection is considered a false positive result.

Prepared By: KALS 1/31/2018

Checked By: LGF 2/1/2018

Table 3
Exposure Point Concentrations (RAGS D: Table 3): Groundwater - Potable Use - Residential Wells at Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

Medium: Groundwater in Private Wells
Exposure Medium: Drinking Water, Shower Water, and Shower Air

Exposure Point		CAS Number	Compound of Potential Concern (1)	Frequency of Detection	Arithmetic Mean of Detects (ug/L)	UCL (2)		Maximum Concentration (Qualifier) (ug/L)	Exposure Point Concentration		
						UCL (ug/L)	Statistical Test		Value (ug/L)	Statistic (3)	Rationale (4)
Property 1, M-24/L-54, Aberjona Watershed											
Semi-Volatile Organic Compounds											
M-24/L-54	Property 1	62-75-9	N-Nitrosodimethylamine	29 / 32	0.014	0.015	95% GROS Adjusted Gamma UCL	0.024	0.015	UCL	UCL ≤ Max
M-24/L-54	Property 1	621-64-7	N-Nitrosodi-n-propylamine	1 / 31	0.024	NC	--	0.024	0.024	Maximum	Low FOD
Metals, Total											
M-24/L-54	Property 1	7440-70-2	Calcium	10 / 10	42390	46754	95% Student's-t UCL	47000	46754	UCL	UCL ≤ Max
M-24/L-54	Property 1	7439-95-4	Magnesium	1 / 1	1430	NC	--	1430	1430	Maximum	Low FOD
M-24/L-54	Property 1	7440-23-5	Sodium	32 / 32	28038	28659	95% Student's-t UCL	31000	28659	UCL	UCL ≤ Max
Inorganics, Total											
M-24/L-54	Property 1	16887-00-6	Chloride	33 / 33	76264	80129	95% Student's-t UCL	89000	80129	UCL	UCL ≤ Max
M-24/L-54	Property 1	HLA0043	Nitrogen, as Ammonia	5 / 33	110	NC	--	160 (J)	160	Maximum	Low FOD
M-24/L-54	Property 1	14808-79-8	Sulfate	33 / 33	25485	26512	95% Student's-t UCL	35000	26512	UCL	UCL ≤ Max
Property 2, M-24/L-94, Aberjona Watershed											
Semi-Volatile Organic Compounds											
M-24/L-94	Property 2	62-75-9	N-Nitrosodimethylamine	23 / 36	0.010	0.012	Gamma Adjusted KM-UCL	0.056	0.012	UCL	UCL ≤ Max
Metals, Dissolved											
M-24/L-94	Property 2	7440-70-2	Calcium	1 / 1	23500	NC	--	23500	23500	Maximum	Low FOD
M-24/L-94	Property 2	7439-95-4	Magnesium	1 / 1	1450	NC	--	1450	1450	Maximum	Low FOD
M-24/L-94	Property 2	7440-09-7	Potassium	1 / 1	2500	NC	--	2500 (J)	2500	Maximum	Low FOD
M-24/L-94	Property 2	7440-23-5	Sodium	1 / 1	26000	NC	--	26000	26000	Maximum	Low FOD
Metals, Total											
M-24/L-94	Property 2	7440-70-2	Calcium	13 / 13	37685	44801	95% Student's-t UCL	67000	44801	UCL	UCL ≤ Max
M-24/L-94	Property 2	7439-95-4	Magnesium	3 / 3	4290	NC	--	5600	5600	Maximum	Low FOD
M-24/L-94	Property 2	7440-09-7	Potassium	3 / 3	2607	NC	--	2620	2620	Maximum	Low FOD
M-24/L-94	Property 2	7440-23-5	Sodium	35 / 35	44637	52511	95% Adjusted Gamma UCL	150000	52511	UCL	UCL ≤ Max
Inorganics, Total											
M-24/L-94	Property 2	16887-00-6	Chloride	37 / 37	100516	125556	95% Adjusted Gamma UCL	320000	125556	UCL	UCL ≤ Max
M-24/L-94	Property 2	14797-55-8	Nitrate as N	35 / 35	1608	1920	95% Student's-t UCL	4800	1920	UCL	UCL ≤ Max
M-24/L-94	Property 2	HLA0043	Nitrogen, as Ammonia	9 / 37	162	72	KM H-UCL	660	72	UCL	UCL ≤ Max
M-24/L-94	Property 2	14808-79-8	Sulfate	37 / 37	20046	21143	95% Student's-t UCL	29000	21143	UCL	UCL ≤ Max

Table 3
Exposure Point Concentrations (RAGS D: Table 3): Groundwater - Potable Use - Residential Wells at Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

Medium: Groundwater in Private Wells
Exposure Medium: Drinking Water, Shower Water, and Shower Air

Exposure Point	CAS Number	Compound of Potential Concern (1)	Frequency of Detection	Arithmetic Mean of Detects (ug/L)	UCL (2)		Maximum Concentration (Qualifier) (ug/L)	Exposure Point Concentration		
					UCL (ug/L)	Statistical Test		Value (ug/L)	Statistic (3)	Rationale (4)

Notes:

EPC - Exposure Point Concentration.

FOD - Frequency of Detection.

NC - Not Calculated.

UCL - Upper Confidence Limit on the arithmetic mean.

(1) Compounds of potential concern (COPCs) are identified in **Table 2**. As discussed in the text, essential nutrients, Nitrogen, as Ammonia, hexavalent chromium, and TICs are not included as COPC for risk calculations. Qualifiers used include:

J - the detected concentration is estimated.

(2) UCL is calculated using ProUCL software (V. 5.1); calculations presented in **Attachment C**. The value shown reflects the recommended value by ProUCL. Where more than one UCL is recommended, the most conservative (highest) recommended UCL is selected. The statistical test for the selected value is shown. If ProUCL recommended a 95% H-UCL the 95% Chebyshev(Mean, Sd) UCL was selected instead, since the 95% H-UCL often results in unstable values. If more than one UCL was recommended and the most conservative was a 95% H-UCL, the next highest UCL was selected.

(3) The selected statistic is shown.

(4) The codes supporting the EPC selection Rationale are as follows:

Low FOD - The maximum detected concentration is selected as the EPC because there is insufficient data to support the UCL calculation (minimum of 6 detects required).

UCL > Max- The maximum detected concentration is selected as the EPC because the calculated UCL exceeded the maximum concentration.

UCL ≤ Max - The UCL is selected as the EPC because there is sufficient data to support this calculation and the calculated UCL is less than the maximum detected concentration.

Prepared by: JPK 2/14/2018

Checked by: LCG 2/15/2018

**Human Health Risk Assessment
Olin OU3
Wilmington, MA**

RECEPTOR POPULATION: Resident
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK				NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
Groundwater	Groundwater	Property 1	N-Nitrosodimethylamine	1.3E-05	--	3.4E-08	1.3E-05	Developmental	0.056	--	0.00015	0.056
			N-Nitrosodi-n-propylamine	1.4E-06	--	4.9E-08	1.5E-06	NA	NC	--	NC	NC
			Chloride	NC	--	NC	NC	NA	NC	--	NC	NC
			Sulfate	NC	--	NC	NC	NA	NC	--	NC	NC
			CHEMICAL TOTAL	1.4E-05	--	8.3E-08	1.5E-05		0.056	--	0.00015	0.06
		EXPOSURE POINT TOTAL					1.5E-05					0.06
	EXPOSURE MEDIUM TOTAL						1.5E-05					0.06
Groundwater	Indoor Air - Vapor	Property 1	N-Nitrosodimethylamine	--	4.6E-07	--	4.6E-07	General Toxicity	--	0.0014	--	0.0014
			N-Nitrosodi-n-propylamine	--	NC	--	NC	NA	--	NC	--	NC
			Chloride	--	NC	--	NC	NA	--	NC	--	NC
			Sulfate	--	NC	--	NC	NA	--	NC	--	NC
			CHEMICAL TOTAL	--	4.6E-07	--	4.6E-07		--	0.0014	--	0.001
		EXPOSURE POINT TOTAL					4.6E-07					0.001
	EXPOSURE MEDIUM TOTAL						4.6E-07					0.001
GROUNDWATER TOTAL							1E-05					0.06
TOTAL RISK ACROSS ALL MEDIA							1E-05	TOTAL HAZARD ACROSS ALL MEDIA				0.06

NC - Not calculated

NA - Not applicable; dose response data not available.

-- - Exposure route not applicable for this chemical/exposure medium.

Checked by: KALS 2/20/2018

Checked by: KALS 2/20/2018

0.0014

0.056

0.056

22

222

—

22

—

==

—

Table 5

Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 1 - Current - Resident - Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
Olin OU3
Wilmington, MA

RECEPTOR POPULATION: Resident
RECEPTOR AGE: Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS						NON-CANCER HAZARD CALCULATIONS					
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC		HAZARD QUOTIENT		
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS			
Groundwater Adult	Groundwater Adult	Property 1	INGESTION	N-Nitrosodimethylamine	0.000015	mg/l	1.3E-07	mg/kg/day	1.02E+02	(mg/kg/day)-1	1.3E-05	4.5E-07	mg/kg/day	8.00E-06	mg/kg/day	0.056		
				N-Nitrosodi-n-propylamine	0.000024	mg/l	2.1E-07	mg/kg/day	7.00E+00	(mg/kg/day)-1	1.4E-06	7.2E-07	mg/kg/day	NA	mg/kg/day	NC		
				Chloride	80	mg/l	NC		NA		NC	2.4E+00	mg/kg/day	NA	mg/kg/day	NC		
				Sulfate	27	mg/l	NC		NA		NC	7.9E-01	mg/kg/day	NA	mg/kg/day	NC		
			EXPOSURE ROUTE TOTAL									1.4E-05	0.056					
			DERMAL CONTACT	N-Nitrosodimethylamine	0.000015	mg/l	3.4E-10	mg/kg/day	1.02E+02	(mg/kg/day)-1	3.4E-08	1.2E-09	mg/kg/day	8.00E-06	mg/kg/day	0.00015		
				N-Nitrosodi-n-propylamine	0.000024	mg/l	7.0E-09	mg/kg/day	7.00E+00	(mg/kg/day)-1	4.9E-08	NC	mg/kg/day	NA	mg/kg/day	NC		
				Chloride	80	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC		
				Sulfate	27	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC		
			EXPOSURE ROUTE TOTAL									8.3E-08	0.00015					
			EXPOSURE POINT TOTAL									1.5E-05	0.056					
		EXPOSURE MEDIUM TOTAL									1.5E-05	0.056						
AIR	Property 1	INHALATION OF SHOWER AIR	N-Nitrosodimethylamine	0.0020	ug/m3	1.6E-05	ug/m3	2.80E-02	(ug/m3)-1	4.6E-07	5.8E-05	ug/m3	4.00E-02	ug/m3	0.0014			
			N-Nitrosodi-n-propylamine	NA		NC					NC				NC			
			Chloride	NA		NC					NC				NC			
			Sulfate	NA		NC					NC				NC			
		EXPOSURE ROUTE TOTAL									4.6E-07	0.0014						
EXPOSURE POINT TOTAL									4.6E-07	0.0014								
EXPOSURE MEDIUM TOTAL									4.6E-07	0.0014								
ADULT GROUNDWATER TOTAL											1E-05	0.06						

NOTES:

NC - Not calculated

NA - Not applicable; dose response data not available.

Prepared by: JPK 2/16/2018

Checked by: KALS 2/20/2018

Table 6
Summary of Receptor Risks and Hazards for COPCs (RAGS D: Table 9) - Reasonable Maximum Exposure - Property 1 - Current - Resident - CHILD - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
 Olin OU3
 Wilmington, MA

RECEPTOR POPULATION: Resident
 RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK				NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
Groundwater	Groundwater	Property 1	N-Nitrosodimethylamine	1.7E-05	--	3.8E-08	1.7E-05	Developmental	0.093	--	0.00020	0.093
			N-Nitrosodi-n-propylamine	7.2E-07	--	2.1E-08	7.4E-07	NA	NC	--	NC	NC
			Chloride	NC	--	NC	NC	NA	NC	--	NC	NC
			Sulfate	NC	--	NC	NC	NA	NC	--	NC	NC
			CHEMICAL TOTAL	1.8E-05	--	5.8E-08	1.8E-05		0.093	--	0.00020	0.093
		EXPOSURE POINT TOTAL					1.8E-05					0.093
	EXPOSURE MEDIUM TOTAL					1.8E-05					0.093	
Groundwater	Indoor Air - Vapor	Property 1	N-Nitrosodimethylamine	--	2.3E-07	--	2.3E-07	General Toxicity	--	0.00089	--	0.00089
			N-Nitrosodi-n-propylamine	--	NC	--	NC	NA	--	NC	--	NC
			Chloride	--	NC	--	NC	NA	--	NC	--	NC
			Sulfate	--	NC	--	NC	NA	--	NC	--	NC
			CHEMICAL TOTAL	--	2.3E-07	--	2.3E-07		--	0.00089	--	0.0009
		EXPOSURE POINT TOTAL					2.3E-07					0.0009
	EXPOSURE MEDIUM TOTAL					2.3E-07					0.0009	
GROUNDWATER TOTAL							2E-05					0.09
TOTAL RISK ACROSS ALL MEDIA							2E-05	TOTAL HAZARD ACROSS ALL MEDIA				0.09

Table 7

Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 1 - Current - Resident - Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
Olin OU3
Wilmington, MARECEPTOR POPULATION: Resident
RECEPTOR AGE: Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

CHILD																	
MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS					
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC		HAZARD QUOTIENT	
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS		
Groundwater Child	Groundwater Child	Property 1	INGESTION	N-Nitrosodimethylamine	0.000015	mg/l	6.4E-08	mg/kg/day	2.7E+02	(mg/kg/day)-1	1.7E-05	7.4E-07	mg/kg/day	8.0E-06	mg/kg/day	0.093	
				N-Nitrosodi-n-propylamine	0.000024	mg/l	1.0E-07	mg/kg/day	7.0E+00	(mg/kg/day)-1	7.2E-07	1.2E-06	mg/kg/day	NA	mg/kg/day	NC	
				Chloride	80	mg/l	NC		NA		NC	4.0E+00	mg/kg/day	NA	mg/kg/day	NC	
				Sulfate	26.512	mg/l	NC		NA		NC	1.3E+00	mg/kg/day	NA	mg/kg/day	NC	
			EXPOSURE ROUTE TOTAL										1.8E-05	0.093			
			DERMAL CONTACT	N-Nitrosodimethylamine	0.000015	mg/l	1.4E-10	mg/kg/day	2.7E+02	(mg/kg/day)-1	3.8E-08	1.6E-09	mg/kg/day	8.0E-06	mg/kg/day	0.00020	
				N-Nitrosodi-n-propylamine	0.000024	mg/l	3.0E-09	mg/kg/day	7.0E+00	(mg/kg/day)-1	2.1E-08	NC	mg/kg/day	NA	mg/kg/day	NC	
				Chloride	80	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC	
				Sulfate	26.512	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC	
			EXPOSURE ROUTE TOTAL										5.8E-08	0.00020			
			EXPOSURE POINT TOTAL										1.8E-05	0.093			
			EXPOSURE MEDIUM TOTAL										1.8E-05	0.093			
AIR	Property 1	INHALATION OF AIR	N-Nitrosodimethylamine	0.0016	ug/m3	3.0E-06	ug/m3	7.5E-02	(ug/m3)-1	2.3E-07	3.5E-05	ug/m3	4.0E-02	ug/m3	0.00089		
			N-Nitrosodi-n-propylamine	NA		NC					NC				NC		
			Chloride	NA		NC					NC				NC		
			Sulfate	NA		NC					NC				NC		
		EXPOSURE ROUTE TOTAL										2.3E-07	0.00089				
EXPOSURE POINT TOTAL										2.3E-07	0.00089						
EXPOSURE MEDIUM TOTAL										2.3E-07	0.00089						
CHILD GROUNDWATER TOTAL										2E-05	0.09						

NOTES:

NC - Not calculated

NA - Not applicable; dose response data not available.

Prepared by: JPK 2/16/2018

Checked by: KALS 2/20/2018

Table 8
Summary of Receptor Risks and Hazards for COPCs (RAGS D: Table 9) - Reasonable Maximum Exposure - Property 2 - Current - Resident - ADULT - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
Olin OU3
Wilmington, MA

RECEPTOR POPULATION: Resident RECEPTOR AGE: ADULT
--

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK				NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
Groundwater	Groundwater	Property 2	N-Nitrosodimethylamine	1.1E-05	--	2.8E-08	1.1E-05	Developmental	0.045	--	0.00012	0.045
			Chloride	NC	--	NC	NC	NA	NC	--	NC	NC
			Nitrate as N	NC	--	NC	NC	Hematological	0.036	--	0.00021	0.036
			Sulfate	NC	--	NC	NC	NA	NC	--	NC	NC
			CHEMICAL TOTAL	1.1E-05	--	2.8E-08	1.1E-05		0.081	--	0.00033	0.082
		EXPOSURE POINT TOTAL					1.1E-05					0.082
	EXPOSURE MEDIUM TOTAL						1.1E-05					0.082
Groundwater	Indoor Air - Vapor	Property 2	N-Nitrosodimethylamine	--	3.7E-07	--	3.7E-07	General Toxicity	--	0.0012	--	0.0012
			Chloride	--	NC	--	NC	NA	--	NC	--	NC
			Nitrate as N	--	NC	--	NC	NA	--	NC	--	NC
			Sulfate	--	NC	--	NC	NA	--	NC	--	NC
			CHEMICAL TOTAL	--	3.7E-07	--	3.7E-07		--	0.0012	--	0.0012
		EXPOSURE POINT TOTAL					3.7E-07					0.0012
	EXPOSURE MEDIUM TOTAL						3.7E-07					0.0012
GROUNDWATER TOTAL							1E-05					0.08
TOTAL RISK ACROSS ALL MEDIA							1E-05	TOTAL HAZARD ACROSS ALL MEDIA				0.08

NOTES:

NC - Not calculated

NA - Not applicable; dose response data not available.

-- - Exposure route not applicable for this chemical/exposure medium.

Prepared by: JPK 2/17/2018

Checked by: KALS 2/20/2018

TOTAL GENERAL TOXICITY HI =	0.0012
	--
TOTAL DEVELOPMENTAL HI =	0.045
	--
	--
	--
TOTAL HEMATOLOGICAL HI =	0.036
	--
	--
	--
	--
	--
	--
	--
	--
	--

Table 9
Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 2 - Current - Resident - Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
Olin OU3
Wilmington, MA

RECEPTOR POPULATION: Resident RECEPTOR AGE: Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
Groundwater Adult	Groundwater Adult	Property 2	INGESTION	N-Nitrosodimethylamine	0.000012	mg/l	1.0E-07	mg/kg/day	1.02E+02	(mg/kg/day)-1	1.1E-05	3.6E-07	mg/kg/day	8.00E-06	mg/kg/day	0.045
				Chloride	126	mg/l	NC		NA		NC	3.8E+00	mg/kg/day	NA	mg/kg/day	NC
				Nitrate as N	1.9	mg/l	NC		NA		NC	5.8E-02	mg/kg/day	1.60E+00	mg/kg/day	0.036
				Sulfate	21	mg/l	NC		NA		NC	6.3E-01	mg/kg/day	NA	mg/kg/day	NC
			EXPOSURE ROUTE TOTAL									1.1E-05	0.081			
			DERMAL CONTACT	N-Nitrosodimethylamine	0.000012	mg/l	2.7E-10	mg/kg/day	1.02E+02	(mg/kg/day)-1	2.8E-08	9.6E-10	mg/kg/day	8.00E-06	mg/kg/day	0.00012
				Chloride	126	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC
				Nitrate as N	1.9	mg/l	NC		NA		NC	3.4E-04	mg/kg/day	1.60E+00	mg/kg/day	0.00021
				Sulfate	21	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC
			EXPOSURE ROUTE TOTAL									2.8E-08	0.00033			
			EXPOSURE POINT TOTAL									1.1E-05	0.082			
		EXPOSURE MEDIUM TOTAL									1.1E-05	0.082				
	AIR	Property 2	INHALATION OF SHOWER AIR	N-Nitrosodimethylamine	0.0016	ug/m3	1.3E-05	ug/m3	2.80E-02	(ug/m3)-1	3.7E-07	4.7E-05	ug/m3	4.00E-02	ug/m3	0.0012
				Chloride	NA	ug/m3	NC		NA		NC	NC		NA		NC
				Nitrate as N	NA	ug/m3	NC		NA		NC	NC		NA		NC
				Sulfate	NA	ug/m3	NC		NA		NC	NC		NA		NC
			EXPOSURE ROUTE TOTAL									3.7E-07	0.0012			
		EXPOSURE POINT TOTAL									3.7E-07	0.0012				
	EXPOSURE MEDIUM TOTAL									3.7E-07	0.0012					
ADULT GROUNDWATER TOTAL											1E-05	0.08				

NOTES:
NC - Not calculated
NA - Not applicable; dose response data not available.

Prepared by: JPK 2/17/2018
Checked by: KALS 2/20/2018

Table 10
Summary of Receptor Risks and Hazards for COPCs (RAGS D: Table 9) - Reasonable Maximum Exposure - Property 2 AVENUE - Current - Resident - CHILD - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
Olin OU3
Wilmington, MA

RECEPTOR POPULATION: Resident RECEPTOR AGE: CHILD
--

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK				NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
Groundwater	Groundwater	Property 2	N-Nitrosodimethylamine	1.4E-05	--	3.0E-08	1.4E-05	Developmental	0.075	--	0.00016	0.076
			Chloride	NC	--	NC	NC	NA	NC	--	NC	NC
			Nitrate as N	NC	--	NC	NC	Hematological	0.060	--	0.00026	0.060
			Sulfate	NC	--	NC	NC	NA	NC	--	NC	NC
			CHEMICAL TOTAL	1.4E-05	--	3.0E-08	1.4E-05		0.14	--	0.00043	0.14
		EXPOSURE POINT TOTAL					1.4E-05					0.14
	EXPOSURE MEDIUM TOTAL					1.4E-05					0.14	
Groundwater	Indoor Air - Vapor	Property 2	N-Nitrosodimethylamine	--	1.8E-07	--	1.8E-07	General Toxicity	--	0.0007	--	0.0007
			Chloride	--	NC	--	NC	NA	--	NC	--	NC
			Nitrate as N	--	NC	--	NC	NA	--	NC	--	NC
			Sulfate	--	NC	--	NC	NA	--	NC	--	NC
			CHEMICAL TOTAL	--	1.8E-07	--	1.8E-07		--	0.0007	--	0.0007
		EXPOSURE POINT TOTAL					1.8E-07					0.0007
	EXPOSURE MEDIUM TOTAL					1.8E-07					0.0007	
GROUNDWATER TOTAL							1E-05					0.1
TOTAL RISK ACROSS ALL MEDIA							1E-05	TOTAL HAZARD ACROSS ALL MEDIA				0.1

Table 11
Calculation of Chemical Cancer Risks and Non-Cancer Hazards (RAGS D: Table 7) -- Reasonable Maximum Exposure - Property 2 - Current - Resident - Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

Human Health Risk Assessment
Olin OU3
Wilmington, MA

RECEPTOR POPULATION: Resident RECEPTOR AGE: Adult and Child - Ingestion, Dermal, and Inhalation (Foster and Chrostowski Model)

CHILD																
MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
Groundwater Child	Groundwater Child	Property 2	INGESTION	N-Nitrosodimethylamine	0.000012	mg/l	5.2E-08	mg/kg/day	2.7E+02	(mg/kg/day)-1	1.4E-05	6.0E-07	mg/kg/day	8.0E-06	mg/kg/day	0.075
				Chloride	126	mg/l	NC		NA		NC	6.3E+00	mg/kg/day	NA	mg/kg/day	NC
				Nitrate as N	1.9	mg/l	NC		NA		NC	9.6E-02	mg/kg/day	1.6E+00	mg/kg/day	0.060
				Sulfate	21	mg/l	NC		NA		NC	1.1E+00	mg/kg/day	NA	mg/kg/day	NC
			EXPOSURE ROUTE TOTAL								1.4E-05					0.14
			DERMAL CONTACT	N-Nitrosodimethylamine	0.000012	mg/l	1.1E-10	mg/kg/day	2.7E+02	(mg/kg/day)-1	3.0E-08	1.3E-09	mg/kg/day	8.0E-06	mg/kg/day	0.00016
				Chloride	126	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC
				Nitrate as N	1.9	mg/l	NC		NA		NC	4.2E-04	mg/kg/day	1.6E+00	mg/kg/day	0.00026
				Sulfate	21	mg/l	NC		NA		NC	NC	mg/kg/day	NA	mg/kg/day	NC
			EXPOSURE ROUTE TOTAL								3.0E-08					0.00043
		EXPOSURE POINT TOTAL								1.4E-05					0.14	
	EXPOSURE MEDIUM TOTAL								1.4E-05					0.14		
	AIR	Property 2	INHALATION OF AIR	N-Nitrosodimethylamine	0.0013	ug/m3	2.5E-06	ug/m3	7.5E-02	(ug/m3)-1	1.8E-07	2.9E-05	ug/m3	4.0E-02	ug/m3	0.00072
				Chloride	NA	ug/m3	NC		NA			NC		NA		NC
				Nitrate as N	NA	ug/m3	NC		NA			NC		NA		NC
				Sulfate	NA	ug/m3	NC		NA			NC		NA		NC
		EXPOSURE ROUTE TOTAL								1.8E-07					0.00072	
	EXPOSURE POINT TOTAL								1.8E-07					0.00072		
EXPOSURE MEDIUM TOTAL								1.8E-07					0.00072			
CHILD GROUNDWATER TOTAL											1E-05					0.1

NOTES:
 NC - Not calculated
 NA - Not applicable; dose response data not available.

Prepared by: JPK 2/17/2018
 Checked by: KALS 2/20/2018

Table 12
Summary of Risks for Private Potable Wells - Property 1 and Property 2
Human Health Risk Assessment
Olin OU3
Wilmington, MA

Exposure Point	Receptor	Exposure Route	HQ	ELCR
Property 1	Adult	ingestion	0.056	1.4E-05
		dermal	0.00015	8.3E-08
		inhalation	0.0014	4.6E-07
	Child	ingestion	0.093	1.8E-05
		dermal	0.00020	5.8E-08
		inhalation	0.00089	2.3E-07
	SUM:		0.09	3E-05
Property 2	Adult	ingestion	0.081	1.1E-05
		dermal	0.00033	2.8E-08
		inhalation	0.0012	3.7E-07
	Child	ingestion	0.14	1.4E-05
		dermal	0.00043	3.0E-08
		inhalation	0.00072	1.8E-07
	SUM:		0.1	3E-05

Notes:

HQ: Hazard Quotient

ELCR: Excess Lifetime Cancer Risk

Sum of HQ is the maximum of the summed hazards for the adult and child.

Sum of ELCR is the sum of risks for both the adult and child.

Prepared by: JPK 2/19/2018

Checked by: LCF 2/19/2018

Attachment A

Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1										
			Sample ID:		Property 1(A)	Property 1(A)	OC-M24L54	OC-M24L54 DUP	OC-M24L54 & OC-M24L54 DUP	OC-M24L54	OC-M24L54	OC-M24L54-DUP	OC-M24L54 & OC-M24L54-DUP	OC-M24L54	OC-M24L54
			Sample Date:		7/20/1995	8/13/1996	10/9/2008			3/18/2009	11/10/2009			3/30/2010	8/4/2010
			Sample Type:		FS	FS	FS	FD	FS & FD	FS	FS	FD	FS & FD	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		71-55-6	1,1,1-Trichloroethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U		
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L							1 U	1 U	1 U		
		79-00-5	1,1,2-Trichloroethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-34-3	1,1-Dichloroethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-35-4	1,1-Dichloroethene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		563-58-6	1,1-Dichloropropene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		87-61-6	1,2,3-Trichlorobenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		96-18-4	1,2,3-Trichloropropane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		120-82-1	1,2,4-Trichlorobenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U	5.1 U	1 U	1 U	1 U		
		95-63-6	1,2,4-Trimethylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L		1 U	0.5 U	0.5 U	0.5 U		5 U	5 U	5 U		
		106-93-4	1,2-Dibromoethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L											
		95-50-1	1,2-Dichlorobenzene (other)	ug/L		1 U	0.5 U	0.5 U	0.5 U	5.1 U	1 U	1 U	1 U		
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L											
		107-06-2	1,2-Dichloroethane	ug/L			0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		540-59-0	1,2-Dichloroethene (total)	ug/L											
		78-87-5	1,2-Dichloropropane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		108-67-8	1,3,5-Trimethylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		541-73-1	1,3-Dichlorobenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U	5.1 U	1 U	1 U	1 U		
		142-28-9	1,3-Dichloropropane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		106-46-7	1,4-Dichlorobenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U	5.1 U	1 U	1 U	1 U		
		123-91-1	1,4-Dioxane	ug/L							50 U	50 U	50 U		
		594-20-7	2,2-Dichloropropane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L		1 U	1 U	1 U	1 U		1 U	1 U	1 U		
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L		1 U	1 U	1 U	1 U		1 U	1 U	1 U		
		78-93-3	2-Butanone	ug/L							10 U	10 U	10 U		
		95-49-8	2-Chlorotoluene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		591-78-6	2-Hexanone	ug/L							10 U	10 U	10 U		
		106-43-4	4-Chlorotoluene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		99-87-6	4-iso-Propyltoluene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		108-10-1	4-Methyl-2-pentanone	ug/L							10 U	10 U	10 U		
		79-20-9	Acetic acid, methyl ester	ug/L							10 U	10 U	10 U		
		67-64-1	Acetone	ug/L							50 U	50 U	50 U		
		71-43-2	Benzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		108-86-1	Bromobenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		74-97-5	Bromochloromethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-27-4	Bromodichloromethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-25-2	Bromoform	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		74-83-9	Bromomethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		2 U	2 U	2 U		
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L							5 U	5 U	5 U		
		75-15-0	Carbon disulfide	ug/L							10 U	10 U	10 U		
		56-23-5	Carbon tetrachloride	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		108-90-7	Chlorobenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-00-3	Chloroethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		2 U	2 U	2 U		
		67-66-3	Chloroform	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		74-87-3	Chloromethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		2 U	2 U	2 U		
		156-59-2	Cis-1,2-Dichloroethene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		10061-01-5	Cis-1,3-Dichloropropene	ug/L			0.5 U	0.5 U	0.5 U		0.4 U	0.4 U	0.4 U		
		110-82-7	Cyclohexane	ug/L							10 U	10 U	10 U		
		124-48-1	Dibromochloromethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U		
		74-95-3	Dibromomethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-71-8	Dichlorodifluoromethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		60-29-7	Diethyl ether	ug/L							10 U	10 U	10 U		
		637-92-3	Ethyl-t-Butyl Ether	ug/L							5 U	5 U	5 U		
		100-41-4	Ethylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		87-68-3	Hexachlorobutadiene	ug/L		1 U	0.5 U	0.5 U	0.5 U	0.4 U	0.4 U	0.4 U	0.4 U		
		108-20-3	Isopropyl ether	ug/L							10 U	10 U	10 U		
		98-82-8	Isopropylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		108-87-2	Methyl cyclohexane	ug/L							10 U	10 U	10 U		
		1634-04-4	Methyl Tertbutyl Ether	ug/L			2.6	3.1	2.85		2	1.9	1.95		
		75-09-2	Methylene chloride	ug/L		1 U	0.5 U	0.5 U	0.5 U		2 U	2 U	2 U		
		104-51-8	n-Butylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1										
			Sample ID:		Property 1(A)	Property 1(A)	OC-M24L54	OC-M24L54 DUP	OC-M24L54 & OC-M24L54 DUP	OC-M24L54	OC-M24L54	OC-M24L54-DUP	OC-M24L54 & OC-M24L54-DUP	OC-M24L54	OC-M24L54
			Sample Date:		7/20/1995	8/13/1996	10/9/2008			3/18/2009	11/10/2009			3/30/2010	8/4/2010
			Sample Type:		FS	FS	FS	FD	FS & FD	FS	FS	FD	FS & FD	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
VOC	T	91-20-3	Naphthalene (8260)	ug/L											
		91-20-3	Naphthalene (other)	ug/L		1 U	0.5 U	0.5 U	0.5 U	1 U	5 U	5 U	5 U		
		91-20-3	Naphthalene (8260 & other)	ug/L											
		103-65-1	Propylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		135-98-8	sec-Butylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		100-42-5	Styrene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		98-06-6	tert-Butylbenzene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		127-18-4	Tetrachloroethene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		109-99-9	Tetrahydrofuran	ug/L							10 U	10 U	10 U		
		108-88-3	Toluene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		156-60-5	trans-1,2-Dichloroethene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		10061-02-6	trans-1,3-Dichloropropene	ug/L			0.5 U	0.5 U	0.5 U		0.4 U	0.4 U	0.4 U		
		79-01-6	Trichloroethene	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		75-69-4	Trichlorofluoromethane	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		108-05-4	Vinyl acetate	ug/L											
		75-01-4	Vinyl chloride	ug/L		1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U		
		95-47-6	Xylene, o	ug/L		1 U	0.5 U	0.5 U	0.5 U		1 U	1 U	1 U		
		179601-23-1	Xylenes (m&p)	ug/L		1 U			1 U		2 U	2 U	2 U		
		1330-20-7	Xylenes, Total	ug/L											
SVOC	T	90-12-0	1-Methylnaphthalene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		108-60-1	2,2'-Dichlorodisopropylether	ug/L							4.9 U	4.5 U	4.5 U		
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L							4.9 U	4.5 U	4.5 U		
		95-95-4	2,4,5-Trichlorophenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		88-06-2	2,4,6-Trichlorophenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		120-83-2	2,4-Dichlorophenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		105-67-9	2,4-Dimethylphenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		51-28-5	2,4-Dinitrophenol	ug/L						5.1 U	4.9 UJ	4.5 UJ	4.5 UJ		
		121-14-2	2,4-Dinitrotoluene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		606-20-2	2,6-Dinitrotoluene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		91-58-7	2-Chloronaphthalene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		95-57-8	2-Chlorophenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		91-57-6	2-Methylnaphthalene	ug/L						1 U	0.97 U	0.91 U	0.91 U		
		95-48-7	2-Methylphenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		88-74-4	2-Nitroaniline	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		88-75-5	2-Nitrophenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		15831-10-4	3 & 4 Methylphenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		91-94-1	3,3'-Dichlorobenzidine	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		108-39-4	3-Methylphenol	ug/L											
		99-09-2	3-Nitroaniline	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		101-55-3	4-Bromophenyl phenyl ether	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		59-50-7	4-Chloro-3-methylphenol	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		106-47-8	4-Chloroaniline	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		106-44-5	4-Methylphenol	ug/L											
		100-01-6	4-Nitroaniline	ug/L							4.9 U	4.5 U	4.5 U		
		100-02-7	4-Nitrophenol	ug/L						5.1 UJ	4.9 UJ	4.5 UJ	4.5 UJ		
		83-32-9	Acenaphthene	ug/L						1 U	0.97 U	0.91 U	0.91 U		
		208-96-8	Acenaphthylene	ug/L		0.1 U				0.3 U	0.29 U	0.27 U	0.27 U		
		98-86-2	Acetophenone	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		309-00-2	Aldrin	ug/L		0.1 U									
		62-53-3	Aniline	ug/L						5.1 UJ	4.9 UJ	4.5 UJ	4.5 UJ		
		120-12-7	Anthracene	ug/L		0.1 U				1 U	0.97 U	0.91 U	0.91 U		
		1912-24-9	Atrazine	ug/L		0.1 U	0.21 U	0.21 U	0.21 U		4.9 U	4.5 U	4.5 U		
		103-33-3	Azobenzene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		100-52-7	Benzaldehyde	ug/L							4.9 U	4.5 U	4.5 U		
		56-55-3	Benzo(a)anthracene	ug/L		0.1 U				0.3 U	0.29 U	0.27 U	0.27 U		
		50-32-8	Benzo(a)pyrene	ug/L		0.02 U	0.21 U	0.21 U	0.21 U	0.2 U	0.19 U	0.18 U	0.18 U		
		205-99-2	Benzo(b)fluoranthene	ug/L		0.1 U				0.3 U	0.29 U	0.27 U	0.27 U		
		191-24-2	Benzo(ghi)perylene	ug/L		0.1 U				0.51 U	0.49 U	0.45 U	0.45 U		
		207-08-9	Benzo(k)fluoranthene	ug/L		0.1 U				0.3 U	0.29 U	0.27 U	0.27 U		
		65-85-0	Benzoic Acid	ug/L											
		100-51-6	Benzyl alcohol	ug/L							9.7 U	9.1 U	9.1 U		
		92-52-4	Biphenyl	ug/L							4.9 U	4.5 U	4.5 U		
		111-91-1	Bis(2-Chloroethoxy)methane	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		111-44-4	Bis(2-Chloroethyl)ether	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L		0.6 U	2.1 U	2.1 U	2.1 U	3 U	1.9 U	1.8 U	1.8 U		
		85-68-7	Butylbenzylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		105-60-2	Caprolactam	ug/L							4.9 U	4.5 U	4.5 U		
		86-74-8	Carbazole	ug/L							4.9 U	4.5 U	4.5 U		
		12789-03-6	Chlordane (technical)	ug/L		0.1 U									
		218-01-9	Chrysene	ug/L		0.1 U				1 U	0.97 U	0.91 U	0.91 U		

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1										
			Sample ID:		Property 1(A)	Property 1(A)	OC-M24L54	OC-M24L54 DUP	OC-M24L54 & OC-M24L54 DUP	OC-M24L54	OC-M24L54	OC-M24L54-DUP	OC-M24L54 & OC-M24L54-DUP	OC-M24L54	OC-M24L54
			Sample Date:		7/20/1995	8/13/1996	10/9/2008			3/18/2009	11/10/2009			3/30/2010	8/4/2010
			Sample Type:		FS	FS	FS	FD	FS & FD	FS	FS	FD	FS & FD	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		117-84-0	Di-n-octylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		53-70-3	Dibenz(a,h)anthracene	ug/L		0.1 U				0.51 U	0.49 U	0.45 U	0.45 U		
		132-64-9	Dibenzofuran	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		60-57-1	Dieldrin	ug/L		0.1 U									
		84-66-2	Diethylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		131-11-3	Dimethylphthalate	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		101-84-8	Diphenyl ether	ug/L							4.9 U	4.5 U	4.5 U		
		119-61-9	Diphenylmethanone	ug/L							4.9 U	4.5 U	4.5 U		
		72-20-8	Endrin	ug/L		0.01 U	0.52 U	0.53 U	0.52 U						
		206-44-0	Fluoranthene	ug/L						1 U	0.97 U	0.91 U	0.91 U		
		86-73-7	Fluorene	ug/L		0.1 U				1 U	0.97 U	0.91 U	0.91 U		
		58-89-9	Gamma-BHC/Lindane	ug/L		0.02 U	0.21 U	0.21 U	0.21 U						
		1024-57-3	Heptachlor epoxide	ug/L		0.02 U	0.21 U	0.21 U	0.21 U						
		76-44-8	Heptachlor	ug/L		0.04 U	0.21 UJ	0.21 UJ	0.21 UJ						
		118-74-1	Hexachlorobenzene	ug/L		0.1 U	0.22 U	0.22 U	0.22 U	1 U	0.97 U	0.91 U	0.91 U		
		77-47-4	Hexachlorocyclopentadiene	ug/L		0.1 U	2.1 UJ	2.1 UJ	2.1 UJ		4.9 UJ	4.5 UJ	4.5 UJ		
		67-72-1	Hexachloroethane	ug/L						3 U	2.9 U	2.7 U	2.7 U		
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L		0.1 U				0.51 U	0.49 U	0.45 U	0.45 U		
		78-59-1	Isophorone	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		72-43-5	Methoxychlor	ug/L		0.1 U	0.52 U	0.53 U	0.52 U						
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L						0.01 U	0.011 U	0.0098 U	0.0098 U	0.024	0.0094 U
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L										0.0019 U	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L											0.0019 U
		62-75-9	N-Nitrosodimethylamine	ug/L			0.0094	0.0088	0.0091	0.019	0.017	0.017	0.017	0.017	0.014
		86-30-6	N-Nitrosodiphenylamine	ug/L							4.9 U	4.5 U	4.5 U		
		98-95-3	Nitrobenzene	ug/L						5.1 U	4.9 U	4.5 U	4.5 U		
		87-86-5	Pentachlorophenol	ug/L						1 U	0.97 U	0.91 U	0.91 U		
		85-01-8	Phenanthrene	ug/L		0.1 U				0.2 U	0.19 U	0.18 U	0.18 U		
		108-95-2	Phenol	ug/L						5.1 UJ	4.9 UJ	4.5 UJ	4.5 UJ		
		129-00-0	Pyrene	ug/L		0.1 U				5.1 U	4.9 U	4.5 U	4.5 U		
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L											
		HLA0156	C9-C10 Aromatics	ug/L											
		HLA0154	C9-C12 Aliphatics	ug/L											
Metals	D	7429-90-5	Aluminum	ug/L											
		7440-36-0	Antimony	ug/L											
		7440-38-2	Arsenic	ug/L											
		7440-43-9	Cadmium	ug/L											
		7440-70-2	Calcium	ug/L											
		7440-47-3	Chromium	ug/L											
		7440-48-4	Cobalt	ug/L											
		7440-50-8	Copper	ug/L											
		7439-89-6	Iron	ug/L											
		7439-92-1	Lead	ug/L											
		7439-95-4	Magnesium	ug/L											
		7439-96-5	Manganese	ug/L											
		7440-02-0	Nickel	ug/L											
		7440-09-7	Potassium	ug/L											
		7782-49-2	Selenium	ug/L											
		7440-22-4	Silver	ug/L											
		7440-23-5	Sodium	ug/L											
		7440-28-0	Thallium	ug/L											
		7440-62-2	Vanadium	ug/L											
		7440-66-6	Zinc	ug/L											

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1													
			Sample ID:		Property 1(A)	Property 1(A)	OC-M24L54	OC-M24L54 DUP	OC-M24L54 & OC-M24L54 DUP	OC-M24L54	OC-M24L54	OC-M24L54-DUP	OC-M24L54 & OC-M24L54-DUP	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54
			Sample Date:		7/20/1995	8/13/1996	10/9/2008			3/18/2009	11/10/2009			3/30/2010	8/4/2010	10/26/2010	12/16/2010	3/30/2011
			Sample Type:		FS	FS	FS	FD	FS & FD	FS	FS	FD	FS & FD	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units														
Metals	T	7429-90-5	Aluminum	ug/L		200 U												
		7440-36-0	Antimony	ug/L		5 U												
		7440-38-2	Arsenic	ug/L		5 U												
		7440-39-3	Barium	ug/L		100 U												
		7440-41-7	Beryllium	ug/L		4 U												
		7440-43-9	Cadmium	ug/L		10 U												
		7440-70-2	Calcium	ug/L		21400	46000	45000	45500	47000	47000	47000	45000	44000	44000	42000	44000	
		18540-29-9	Chromium, Hexavalent	ug/L														
		7440-47-3	Chromium	ug/L	15 U	30 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	
		7440-48-4	Cobalt	ug/L		50 U												
		7440-50-8	Copper	ug/L		20 U												
		7439-89-6	Iron	ug/L		30 U												
		7439-92-1	Lead	ug/L		5 U												
		7439-95-4	Magnesium	ug/L		1430												
		7439-96-5	Manganese	ug/L		15												
		7439-97-6	Mercury	ug/L		0.5 U												
		7440-02-0	Nickel	ug/L		30 U												
		7440-09-7	Potassium	ug/L		500 U												
		7782-49-2	Selenium	ug/L		5 U												
7440-22-4	Silver	ug/L		20 U														
7440-23-5	Sodium	ug/L		23200	31000	30000	30500	28000	27000	27500	27000	28000	26000	26000	27000			
7440-28-0	Thallium	ug/L		5 U														
7440-62-2	Vanadium	ug/L		50 U														
7440-66-6	Zinc	ug/L		20 U														
Inorganics	T	16887-00-6	Chloride	ug/L	36,000	33,200	72,000	71,000	71,500		72,000	72,000	72,000	76,000	76,000	86,000	48,000	74,000
		14797-55-8	Nitrate as N	ug/L		100 U	50 U	50 U	50 U		50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
		14797-65-0	Nitrite as N	ug/L		5 U	10 U	10 U	10 U		10 U	10 U	10 U	10 U	100 U	10 U	10 U	100 U
		HLA0043	Nitrogen, as Ammonia	ug/L	100 U	500 U	100 U	100 U	100 U		100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
		14808-79-8	Sulfate	ug/L	13,000	21,000	26,000	26,000	26,000		27,000	27,000	27,000	27,000	28,000	31,000	27,000	25,000
Specialty	T	75-07-0	Acetaldehyde	ug/L						100 U	30 U	30 U	30 U					
		50-00-0	Formaldehyde	ug/L						50 U	30 U	30 U	30 U					
		302-01-2	Hydrazine	ug/L						0.05 U	0.2 U	0.2 U	0.2 U					
		123-77-3	Kempore (Azodicarbonamide)	ug/L														
		60-34-4	Monomethylhydrazine (MMH)	ug/L						0.25 U	0.5 U	0.5 U	0.5 U					
		101-25-7	OPEX	ug/L														
		HLA0454	Phthalic Acid/Phthalic anhydride	ug/L														
57-14-7	UDMH	ug/L						0.25 U	0.5 U	0.5 U	0.5 U							
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L														
		506-12-7	Heptadecanoic Acid	ug/L														
		57-10-3	Hexadecanoic acid	ug/L														
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L														
		HLA0197	TIC Organic Acid(s)	ug/L														
		HLA0141	TIC PAH(s)	ug/L														
		HLA0058	TIC(s) Unspecified	ug/L														
HLA0650	Unknown Hydrocarbons	ug/L																

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1														
			Sample ID:		OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54		
			Sample Date:		7/19/2011	10/12/2011	2/28/2012	5/16/2012	10/8/2012	1/15/2013	5/21/2013	9/11/2013	12/19/2013	2/25/2014	5/20/2014	9/10/2014	12/15/2014	3/24/2015	
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units															
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L															
		71-55-6	1,1,1-Trichloroethane	ug/L															
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L															
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L															
		79-00-5	1,1,2-Trichloroethane	ug/L															
		75-34-3	1,1-Dichloroethane	ug/L															
		75-35-4	1,1-Dichloroethene	ug/L															
		563-58-6	1,1-Dichloropropene	ug/L															
		87-61-6	1,2,3-Trichlorobenzene	ug/L															
		96-18-4	1,2,3-Trichloropropane	ug/L															
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U	
		120-82-1	1,2,4-Trichlorobenzene	ug/L								4.8 U							
		95-63-6	1,2,4-Trimethylbenzene	ug/L															
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L															
		106-93-4	1,2-Dibromoethane	ug/L															
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L															
		95-50-1	1,2-Dichlorobenzene (other)	ug/L							0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L															
		107-06-2	1,2-Dichloroethane	ug/L															
		540-59-0	1,2-Dichloroethene (total)	ug/L															
		78-87-5	1,2-Dichloropropane	ug/L															
		108-67-8	1,3,5-Trimethylbenzene	ug/L															
		541-73-1	1,3-Dichlorobenzene	ug/L									4.8 U						
		142-28-9	1,3-Dichloropropane	ug/L															
		106-46-7	1,4-Dichlorobenzene	ug/L									4.8 U						
		123-91-1	1,4-Dioxane	ug/L															
		594-20-7	2,2-Dichloropropane	ug/L															
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L															
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L															
		78-93-3	2-Butanone	ug/L															
		95-49-8	2-Chlorotoluene	ug/L															
		591-78-6	2-Hexanone	ug/L															
		106-43-4	4-Chlorotoluene	ug/L															
		99-87-6	4-iso-Propyltoluene	ug/L															
		108-10-1	4-Methyl-2-pentanone	ug/L															
		79-20-9	Acetic acid, methyl ester	ug/L															
		67-64-1	Acetone	ug/L															
		71-43-2	Benzene	ug/L															
		108-86-1	Bromobenzene	ug/L															
		74-97-5	Bromochloromethane	ug/L															
		75-27-4	Bromodichloromethane	ug/L															
		75-25-2	Bromoform	ug/L															
		74-83-9	Bromomethane	ug/L															
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L															
		75-15-0	Carbon disulfide	ug/L															
		56-23-5	Carbon tetrachloride	ug/L															
		108-90-7	Chlorobenzene	ug/L															
		75-00-3	Chloroethane	ug/L															
		67-66-3	Chloroform	ug/L															
		74-87-3	Chloromethane	ug/L															
		156-59-2	Cis-1,2-Dichloroethene	ug/L															
		10061-01-5	Cis-1,3-Dichloropropene	ug/L															
		110-82-7	Cyclohexane	ug/L															
		124-48-1	Dibromochloromethane	ug/L															
		74-95-3	Dibromomethane	ug/L															
		75-71-8	Dichlorodifluoromethane	ug/L															
		60-29-7	Diethyl ether	ug/L															
		637-92-3	Ethyl-t-Butyl Ether	ug/L															
		100-41-4	Ethylbenzene	ug/L															
		87-68-3	Hexachlorobutadiene	ug/L									0.38 U						
		108-20-3	Isopropyl ether	ug/L															
		98-82-8	Isopropylbenzene	ug/L															
		108-87-2	Methyl cyclohexane	ug/L															
		1634-04-4	Methyl Tertbutyl Ether	ug/L															
		75-09-2	Methylene chloride	ug/L															
		104-51-8	n-Butylbenzene	ug/L															

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1													
			Sample ID:		OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	
			Sample Date:		7/19/2011	10/12/2011	2/28/2012	5/16/2012	10/8/2012	1/15/2013	5/21/2013	9/11/2013	12/19/2013	2/25/2014	5/20/2014	9/10/2014	12/15/2014	3/24/2015
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units														
VOC	T	91-20-3	Naphthalene (8260)	ug/L														
		91-20-3	Naphthalene (other)	ug/L								0.95 U						
		91-20-3	Naphthalene (8260 & other)	ug/L														
		103-65-1	Propylbenzene	ug/L														
		135-98-8	sec-Butylbenzene	ug/L														
		100-42-5	Styrene	ug/L														
		98-06-6	tert-Butylbenzene	ug/L														
		127-18-4	Tetrachloroethene	ug/L														
		109-99-9	Tetrahydrofuran	ug/L														
		108-88-3	Toluene	ug/L														
		156-60-5	trans-1,2-Dichloroethene	ug/L														
		10061-02-6	trans-1,3-Dichloropropene	ug/L														
		79-01-6	Trichloroethene	ug/L														
		75-69-4	Trichlorofluoromethane	ug/L														
		108-05-4	Vinyl acetate	ug/L														
		75-01-4	Vinyl chloride	ug/L														
		95-47-6	Xylene, o	ug/L														
179601-23-1	Xylenes (m&p)	ug/L																
1330-20-7	Xylenes, Total	ug/L																
SVOC	T	90-12-0	1-Methylnaphthalene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.19 U	0.19 U	0.19 U
		108-60-1	2,2'-Dichlorodiisopropylether	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 UJ	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	9.5 U	9.5 U	9.5 U
		95-95-4	2,4,5-Trichlorophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U
		88-06-2	2,4,6-Trichlorophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U
		120-83-2	2,4-Dichlorophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		105-67-9	2,4-Dimethylphenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 UJ	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		51-28-5	2,4-Dinitrophenol	ug/L		4.8 UJ	5.1 UJ	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U
		121-14-2	2,4-Dinitrotoluene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U
		606-20-2	2,6-Dinitrotoluene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U
		91-58-7	2-Chloronaphthalene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		95-57-8	2-Chlorophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		91-57-6	2-Methylnaphthalene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.95 U	0.95 U	0.96 UJ	0.96 U	0.19 U	0.19 U	0.19 U
		95-48-7	2-Methylphenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		88-74-4	2-Nitroaniline	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	4.8 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		88-75-5	2-Nitrophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		15831-10-4	3 & 4 Methylphenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		91-94-1	3,3'-Dichlorobenzidine	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	1.9 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U
		108-39-4	3-Methylphenol	ug/L														
		99-09-2	3-Nitroaniline	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	4.8 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 UJ	1.9 U	1.9 U	1.9 U
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	4.8 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 U
		101-55-3	4-Bromophenyl phenyl ether	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		59-50-7	4-Chloro-3-methylphenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	1.9 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		106-47-8	4-Chloroaniline	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	1.9 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		106-44-5	4-Methylphenol	ug/L						0.95 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U			
		100-01-6	4-Nitroaniline	ug/L		4.8 UJ	5.1 U	4.7 UJ	4.7 U	4.8 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		100-02-7	4-Nitrophenol	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 UJ	4.8 U	4.8 U	4.8 U		4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U
		83-32-9	Acenaphthene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.95 U	0.95 U	0.96 U	0.96 U	0.19 U	0.19 U	0.19 U
		208-96-8	Acenaphthylene	ug/L		0.29 UJ	0.31 U	0.28 U	0.28 U	0.96 U	0.29 U	0.96 U	0.29 U	0.29 U	0.29 U	0.19 U	0.19 U	0.19 U
		98-86-2	Acetophenone	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		309-00-2	Aldrin	ug/L														
		62-53-3	Aniline	ug/L		4.8 UJ	5.1 UJ	4.7 U	4.7 UJ	0.96 U	4.8 U	4.8 U	4.7 U	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U
		120-12-7	Anthracene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.95 U	0.95 U	0.96 U	0.96 U	0.19 U	0.19 U	0.19 U
		1912-24-9	Atrazine	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		103-33-3	Azobenzene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	9.5 U	9.5 U	9.5 U
		100-52-7	Benzaldehyde	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	0.13 J	4.8 UJ	4.8 U	0.95 U	0.95 U	0.95 U
		56-55-3	Benzo(a)anthracene	ug/L		0.29 UJ	0.31 U	0.28 U	0.28 U	0.96 U	0.29 U	0.96 U	0.28 U	0.29 U	0.29 U	0.19 U	0.19 U	0.19 U
		50-32-8	Benzo(a)pyrene	ug/L		0.19 UJ	0.2 U	0.19 U	0.19 U	0.96 U	0.19 U	0.96 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U
		205-99-2	Benzo(b)fluoranthene	ug/L		0.29 UJ	0.31 U	0.28 U	0.28 U	0.96 U	0.29 U	0.96 U	0.28 U	0.29 U	0.29 U	0.19 U	0.19 U	0.19 U
		191-24-2	Benzo(ghi)perylene	ug/L		0.48 UJ	0.51 U	0.47 U	0.47 U	0.96 U	0.48 U	0.48 U	0.47 U	0.48 U	0.48 UJ	0.19 U	0.19 U	0.19 U
		207-08-9	Benzo(k)fluoranthene	ug/L		0.29 UJ	0.31 U	0.28 U	0.28 U	0.96 U	0.29 U	0.96 U	0.28 U	0.29 U	0.29 U	0.19 U	0.19 U	0.19 U
		65-85-0	Benzoic Acid	ug/L		4.8 UJ	5.1 UJ	4.7 UJ	4.7 UJ	4.8 UJ	4.8 UJ			4.8 U	4.8 U	24 UJ	24 UJ	24 UJ
		100-51-6	Benzyl alcohol	ug/L		9.7 UJ	10 U	9.4 U	9.4 U	1.9 U	9.6 U	9.5 U						

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 1													
			Sample ID:		OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	
			Sample Date:		7/19/2011	10/12/2011	2/28/2012	5/16/2012	10/8/2012	1/15/2013	5/21/2013	9/11/2013	12/19/2013	2/25/2014	5/20/2014	9/10/2014	12/15/2014	3/24/2015
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units														
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	4.8 U	4.8 U	4.8 U	4.7 U	0.43 J	1 J	4.8 U	4.8 U	4.8 U
		117-84-0	Di-n-octylphthalate	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 UJ	4.8 U	4.8 UJ	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		53-70-3	Dibenz(a,h)anthracene	ug/L		0.48 UJ	0.51 U	0.47 U	0.47 U	0.96 U	0.48 U	0.48 U	0.47 U	0.48 U	0.48 UJ	0.19 U	0.19 U	0.19 U
		132-64-9	Dibenzofuran	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		60-57-1	Dieldrin	ug/L														
		84-66-2	Diethylphthalate	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	0.075 J	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		131-11-3	Dimethylphthalate	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	1.9 U	1.9 U	1.9 U
		101-84-8	Diphenyl ether	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 UJ	9.5 U	9.5 U	9.5 U
		119-61-9	Diphenylmethanone	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U
		72-20-8	Endrin	ug/L														
		206-44-0	Fluoranthene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.084 J	0.95 U	0.96 U	0.96 U	0.19 U	0.19 U	0.19 U
		86-73-7	Fluorene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.95 U	0.95 U	0.96 U	0.96 U	0.19 U	0.19 U	0.19 U
		58-89-9	Gamma-BHC/Lindane	ug/L														
		1024-57-3	Heptachlor epoxide	ug/L														
		76-44-8	Heptachlor	ug/L														
		118-74-1	Hexachlorobenzene	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.95 U	0.95 U	0.96 U	0.96 U	0.19 U	0.19 U	0.19 U
		77-47-4	Hexachlorocyclopentadiene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	1.9 U	4.8 UJ	4.8 UJ	4.7 UJ	4.8 U	4.8 U	9.5 UJ	9.5 U	9.5 U
		67-72-1	Hexachloroethane	ug/L		2.9 UJ	3.1 U	2.8 U	2.8 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L		0.48 UJ	0.51 U	0.47 U	0.47 U	0.96 U	0.48 U	0.48 U	0.47 U	0.48 U	0.48 UJ	0.19 U	0.19 U	0.19 U
		78-59-1	Isophorone	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		72-43-5	Methoxychlor	ug/L														
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L											4.8 U	0.95 U	0.95 U	0.95 U
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L											0.0019 U	0.0019 U	0.0019 U	0.0019 U
		62-75-9	N-Nitrosodimethylamine	ug/L	0.016	0.012	0.012	0.013 J	0.016	0.013	0.011	0.013	0.0019 U	0.01	0.011	0.012	0.022	0.01
		86-30-6	N-Nitrosodiphenylamine	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		98-95-3	Nitrobenzene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 UJ	4.8 U	0.95 U	0.95 U	0.95 U
		87-86-5	Pentachlorophenol	ug/L		0.97 UJ	1 U	0.94 U	0.94 U	0.96 U	0.96 U	0.95 UJ	0.95 U	0.96 U	0.96 U	4.8 U	4.8 U	4.8 U
		85-01-8	Phenanthrene	ug/L		0.19 UJ	0.2 U	0.19 U	0.38 U	0.96 U	0.38 U	0.38 U	0.38 U	0.066 J	0.11 J	0.19 U	0.19 U	0.19 U
		108-95-2	Phenol	ug/L		4.8 UJ	5.1 U	4.7 UJ	4.7 UJ	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.95 U	0.95 U	0.95 U
		129-00-0	Pyrene	ug/L		4.8 UJ	5.1 U	4.7 U	4.7 U	0.96 U	4.8 U	4.8 U	4.7 U	4.8 U	4.8 U	0.19 U	0.19 U	0.19 U
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L														
		HLA0156	C9-C10 Aromatics	ug/L														
		HLA0154	C9-C12 Aliphatics	ug/L														
Metals	D	7429-90-5	Aluminum	ug/L														
		7440-36-0	Antimony	ug/L														
		7440-38-2	Arsenic	ug/L														
		7440-43-9	Cadmium	ug/L														
		7440-70-2	Calcium	ug/L														
		7440-47-3	Chromium	ug/L														
		7440-48-4	Cobalt	ug/L														
		7440-50-8	Copper	ug/L														
		7439-89-6	Iron	ug/L														
		7439-92-1	Lead	ug/L														
		7439-95-4	Magnesium	ug/L														
		7439-96-5	Manganese	ug/L														
		7440-02-0	Nickel	ug/L														
		7440-09-7	Potassium	ug/L														
		7782-49-2	Selenium	ug/L														
		7440-22-4	Silver	ug/L														
		7440-23-5	Sodium	ug/L														
		7440-28-0	Thallium	ug/L														
		7440-62-2	Vanadium	ug/L														
		7440-66-6	Zinc	ug/L														

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1											
			Sample ID:	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54
			Sample Date:	7/19/2011	10/12/2011	2/28/2012	5/16/2012	10/8/2012	1/15/2013	5/21/2013	9/11/2013	12/19/2013	2/25/2014	5/20/2014	9/10/2014
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
Metals	T	7429-90-5	Aluminum	ug/L	44000							47000			
		7440-36-0	Antimony	ug/L											
		7440-38-2	Arsenic	ug/L											
		7440-39-3	Barium	ug/L											
		7440-41-7	Beryllium	ug/L											
		7440-43-9	Cadmium	ug/L											
		7440-70-2	Calcium	ug/L											
		18540-29-9	Chromium, Hexavalent	ug/L											
		7440-47-3	Chromium	ug/L											
		7440-48-4	Cobalt	ug/L											
		7440-50-8	Copper	ug/L											
		7439-89-6	Iron	ug/L											
		7439-92-1	Lead	ug/L											
		7439-95-4	Magnesium	ug/L											
		7439-96-5	Manganese	ug/L											
		7439-97-6	Mercury	ug/L											
		7440-02-0	Nickel	ug/L											
		7440-09-7	Potassium	ug/L											
		7782-49-2	Selenium	ug/L											
Inorganics	T	7440-22-4	Silver	ug/L	25000	27000	28000	30000	25000	29000	28000	30000	30000	27000	28000
		7440-23-5	Sodium	ug/L											
		7440-28-0	Thallium	ug/L											
		7440-62-2	Vanadium	ug/L											
		7440-66-6	Zinc	ug/L											
		16887-00-6	Chloride	ug/L	76,000	75,000	80,000	87,000	82,000 J	86,000	88,000	86,000	78,000	80,000	77,000
		14797-55-8	Nitrate as N	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	69	50 U	31 J	110	45 J
		14797-65-0	Nitrite as N	ug/L	10 U	10 U	100 U	100 U	100 U	50 U	50 U	50 U	50 U	50 U	50 U
		HLA0043	Nitrogen, as Ammonia	ug/L	100 U	100 U	100 U	100 U	100 U	20 U	20	20 U	20 U	20 U	20 UJ
		14808-79-8	Sulfate	ug/L	23,000	27,000	26,000	26,000	27,000	25,000	25,000	27,000	24,000	28,000	26,000
Specialty	T	75-07-0	Acetaldehyde	ug/L											
		50-00-0	Formaldehyde	ug/L											
		302-01-2	Hydrazine	ug/L											
		123-77-3	Kempore (Azodicarbonamide)	ug/L											
		60-34-4	Monomethylhydrazine (MMH)	ug/L											
		101-25-7	OPEX	ug/L											
		HLA0454	Phthalic Acid/Phthalic anhydride	ug/L											
TIC	T	57-14-7	UDMH	ug/L											
		2050-75-1	2,3-Dichloronaphthalene	ug/L											
		506-12-7	Heptadecanoic Acid	ug/L											
		57-10-3	Hexadecanoic acid	ug/L											
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L											
		HLA0197	TIC Organic Acid(s)	ug/L											
		HLA0141	TIC PAH(s)	ug/L											
		HLA0058	TIC(s) Unspecified	ug/L											
		HLA0650	Unknown Hydrocarbons	ug/L											

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
 if both results are ND, then the lower reporting limit is shown.
 if both results are detected, then the average of the detected values is shown.
 if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
 and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1										Property 2			
			Sample ID:	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	Property 2(A)	Property 2(A)	Property 2(A)	
			Sample Date:	6/29/2015	9/29/2015	1/27/2016	3/2/2016	6/29/2016	9/28/2016	12/6/2016	1/4/2017	3/28/2017	6/28/2017	9/27/2017	7/20/1995	8/13/1996	4/23/1998
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units													
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L												1 U	
		71-55-6	1,1,1-Trichloroethane	ug/L												1 U	
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L												1 U	
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L													
		79-00-5	1,1,2-Trichloroethane	ug/L												1 U	
		75-34-3	1,1-Dichloroethane	ug/L												1 U	
		75-35-4	1,1-Dichloroethene	ug/L												1 U	
		563-58-6	1,1-Dichloropropene	ug/L												1 U	
		87-61-6	1,2,3-Trichlorobenzene	ug/L												1 U	
		96-18-4	1,2,3-Trichloropropane	ug/L												1 U	
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ		
		120-82-1	1,2,4-Trichlorobenzene	ug/L												1 U	
		95-63-6	1,2,4-Trimethylbenzene	ug/L												1 U	
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L												1 U	
		106-93-4	1,2-Dibromoethane	ug/L												1 U	
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L													
		95-50-1	1,2-Dichlorobenzene (other)	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	1 U	
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L													
		107-06-2	1,2-Dichloroethane	ug/L													
		540-59-0	1,2-Dichloroethene (total)	ug/L													
		78-87-5	1,2-Dichloropropane	ug/L												1 U	
		108-67-8	1,3,5-Trimethylbenzene	ug/L												1 U	
		541-73-1	1,3-Dichlorobenzene	ug/L												1 U	
		142-28-9	1,3-Dichloropropane	ug/L												1 U	
		106-46-7	1,4-Dichlorobenzene	ug/L												1 U	
		123-91-1	1,4-Dioxane	ug/L													
		594-20-7	2,2-Dichloropropane	ug/L												1 U	
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L												1 U	
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L												1 U	
		78-93-3	2-Butanone	ug/L													
		95-49-8	2-Chlorotoluene	ug/L												1 U	
		591-78-6	2-Hexanone	ug/L													
		106-43-4	4-Chlorotoluene	ug/L												1 U	
		99-87-6	4-iso-Propyltoluene	ug/L												1 U	
		108-10-1	4-Methyl-2-pentanone	ug/L													
		79-20-9	Acetic acid, methyl ester	ug/L													
		67-64-1	Acetone	ug/L													
		71-43-2	Benzene	ug/L												1 U	
		108-86-1	Bromobenzene	ug/L												1 U	
		74-97-5	Bromochloromethane	ug/L												1 U	
		75-27-4	Bromodichloromethane	ug/L												1 U	
		75-25-2	Bromoform	ug/L												1 U	
		74-83-9	Bromomethane	ug/L												1 U	
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L													
		75-15-0	Carbon disulfide	ug/L													
		56-23-5	Carbon tetrachloride	ug/L												1 U	
		108-90-7	Chlorobenzene	ug/L												1 U	
		75-00-3	Chloroethane	ug/L												1 U	
		67-66-3	Chloroform	ug/L												1 U	
		74-87-3	Chloromethane	ug/L												1 U	
156-59-2	Cis-1,2-Dichloroethene	ug/L												1 U			
10061-01-5	Cis-1,3-Dichloropropene	ug/L															
110-82-7	Cyclohexane	ug/L															
124-48-1	Dibromochloromethane	ug/L												1 U			
74-95-3	Dibromomethane	ug/L												1 U			
75-71-8	Dichlorodifluoromethane	ug/L												1 U			
60-29-7	Diethyl ether	ug/L															
637-92-3	Ethyl-t-Butyl Ether	ug/L															
100-41-4	Ethylbenzene	ug/L												1 U			
87-68-3	Hexachlorobutadiene	ug/L												1 U			
108-20-3	Isopropyl ether	ug/L															
98-82-8	Isopropylbenzene	ug/L												1 U			
108-87-2	Methyl cyclohexane	ug/L															
1634-04-4	Methyl Tertbutyl Ether	ug/L															
75-09-2	Methylene chloride	ug/L												1 U			
104-51-8	n-Butylbenzene	ug/L												1 U			

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1										Property 2		
			Sample ID:	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	Property 2(A)	Property 2(A)	Property 2(A)
			Sample Date:	6/29/2015	9/29/2015	1/27/2016	3/2/2016	6/29/2016	9/28/2016	12/6/2016	1/4/2017	3/28/2017	6/28/2017	7/20/1995	8/13/1996	4/23/1998
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units												
VOC	T	91-20-3	Naphthalene (8260)	ug/L												
		91-20-3	Naphthalene (other)	ug/L											1 U	
		91-20-3	Naphthalene (8260 & other)	ug/L												
		103-65-1	Propylbenzene	ug/L											1 U	
		135-98-8	sec-Butylbenzene	ug/L											1 U	
		100-42-5	Styrene	ug/L											1 U	
		98-06-6	tert-Butylbenzene	ug/L											1 U	
		127-18-4	Tetrachloroethene	ug/L											1 U	
		109-99-9	Tetrahydrofuran	ug/L												
		108-88-3	Toluene	ug/L											1 U	
		156-60-5	trans-1,2-Dichloroethene	ug/L											1 U	
		10061-02-6	trans-1,3-Dichloropropene	ug/L												
		79-01-6	Trichloroethene	ug/L											1 U	
		75-69-4	Trichlorofluoromethane	ug/L											1 U	
		108-05-4	Vinyl acetate	ug/L												
		75-01-4	Vinyl chloride	ug/L											1 U	
SVOC	T	95-47-6	Xylene, o	ug/L											1 U	
		179601-23-1	Xylenes (m&p)	ug/L											1 U	
		1330-20-7	Xylenes, Total	ug/L											1 U	
		90-12-0	1-Methylnaphthalene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	
		108-60-1	2,2'-Dichlorodisopropylether	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U		9.5 U	9.5 U	9.5 U	9.5 UJ	
		95-95-4	2,4,5-Trichlorophenol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		88-06-2	2,4,6-Trichlorophenol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		120-83-2	2,4-Dichlorophenol	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		105-67-9	2,4-Dimethylphenol	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		51-28-5	2,4-Dinitrophenol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 UJ	4.8 UJ	
		121-14-2	2,4-Dinitrotoluene	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		606-20-2	2,6-Dinitrotoluene	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		91-58-7	2-Chloronaphthalene	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		95-57-8	2-Chlorophenol	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		91-57-6	2-Methylnaphthalene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	
		95-48-7	2-Methylphenol	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		88-74-4	2-Nitroaniline	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		88-75-5	2-Nitrophenol	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		15831-10-4	3 & 4 Methylphenol	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		91-94-1	3,3'-Dichlorobenzidine	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		108-39-4	3-Methylphenol	ug/L												
		99-09-2	3-Nitroaniline	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		101-55-3	4-Bromophenyl phenyl ether	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		59-50-7	4-Chloro-3-methylphenol	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		106-47-8	4-Chloroaniline	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		106-44-5	4-Methylphenol	ug/L												
		100-01-6	4-Nitroaniline	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		100-02-7	4-Nitrophenol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	4.8 UJ	
		83-32-9	Acenaphthene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	
		208-96-8	Acenaphthylene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U
		98-86-2	Acetophenone	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		309-00-2	Aldrin	ug/L												
		62-53-3	Aniline	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	0.1 U
		120-12-7	Anthracene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U
		1912-24-9	Atrazine	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	0.1 U
		103-33-3	Azobenzene	ug/L	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U		9.5 U	9.5 U	9.5 U	9.5 UJ	
		100-52-7	Benzaldehyde	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		56-55-3	Benzo(a)anthracene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U
		50-32-8	Benzo(a)pyrene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.02 U
		205-99-2	Benzo(b)fluoranthene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U
		191-24-2	Benzo(ghi)perylene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U
		207-08-9	Benzo(k)fluoranthene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U
		65-85-0	Benzoic Acid	ug/L	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ		2.5 J	24 UJ	24 UJ	24 UJ	
		100-51-6	Benzyl alcohol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	
		92-52-4	Biphenyl	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		111-91-1	Bis(2-Chloroethoxy)methane	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		111-44-4	Bis(2-Chloroethyl)ether	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L	1.7 J	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ	1
		85-68-7	Butylbenzylphthalate	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ	
		105-60-2	Caprolactam	ug/L	4.8 UJ	4.8 U	0.25 J	4.8 UJ	0.25 J	4.8 UJ		4.8 UJ	0.3 J	4.8 U	4.8 UJ	
		86-74-8	Carbazole	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ	
		12789-03-6	Chlordane (technical)	ug/L											0.1 U	
		218-01-9	Chrysene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ	0.1 U

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1											Property 2		
			Sample ID:	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	Property 2(A)	Property 2(A)	Property 2(A)
			Sample Date:	6/29/2015	9/29/2015	1/27/2016	3/2/2016	6/29/2016	9/28/2016	12/6/2016	1/4/2017	3/28/2017	6/28/2017	9/27/2017	7/20/1995	8/13/1996	4/23/1998
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units													
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ			
		117-84-0	Di-n-octylphthalate	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ			
		53-70-3	Dibenz(a,h)anthracene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		0.1 U	
		132-64-9	Dibenzofuran	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ			
		60-57-1	Dieldrin	ug/L												0.1 U	
		84-66-2	Diethylphthalate	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		3.1 U	1.9 U	1.9 U	1.9 UJ			
		131-11-3	Dimethylphthalate	ug/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 U	1.9 U	1.9 UJ			
		101-84-8	Diphenyl ether	ug/L	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U		9.5 U	9.5 U	9.5 U	9.5 UJ			
		119-61-9	Diphenylmethanone	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ			
		72-20-8	Endrin	ug/L												0.01 U	
		206-44-0	Fluoranthene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ			
		86-73-7	Fluorene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		0.1 U	
		58-89-9	Gamma-BHC/Lindane	ug/L												0.02 U	
		1024-57-3	Heptachlor epoxide	ug/L												0.02 U	
		76-44-8	Heptachlor	ug/L												0.04 U	
		118-74-1	Hexachlorobenzene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		0.1 U	
		77-47-4	Hexachlorocyclopentadiene	ug/L	9.5 U	9.5 U	9.5 U	9.5 U	9.5 UJ		9.5 U	9.5 U	9.5 U	9.5 UJ		0.1 U	
		67-72-1	Hexachloroethane	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ			
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		0.1 U	
		78-59-1	Isophorone	ug/L	0.95 U	0.95 U	0.95 U	0.95 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ			
		72-43-5	Methoxychlor	ug/L												0.1 U	
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L	0.95 U	0.95 U	0.95 U	0.25 U									
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 UJ		0.0019 U		0.0019 U	0.0019 UJ			
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U									
		62-75-9	N-Nitrosodimethylamine	ug/L	0.0094	0.012	0.014 J	0.012	0.024		0.0019 U	0.0019 U	0.016	0.011		0.015 J	
		86-30-6	N-Nitrosodiphenylamine	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ			
		98-95-3	Nitrobenzene	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U		0.95 U	0.95 U	0.95 U	0.95 UJ			
		87-86-5	Pentachlorophenol	ug/L	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 U	4.8 U	4.8 UJ			
		85-01-8	Phenanthrene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		0.1 U	
		108-95-2	Phenol	ug/L	0.95 U	0.95 U	0.95 U	0.25 U	0.95 U		0.95 UJ	0.95 UJ	0.95 U	0.95 UJ			
		129-00-0	Pyrene	ug/L	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 U	0.19 U	0.19 UJ		0.1 U	
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L													
		HLA0156	C9-C10 Aromatics	ug/L													
		HLA0154	C9-C12 Aliphatics	ug/L													
Metals	D	7429-90-5	Aluminum	ug/L													
		7440-36-0	Antimony	ug/L													
		7440-38-2	Arsenic	ug/L													
		7440-43-9	Cadmium	ug/L													
		7440-70-2	Calcium	ug/L													
		7440-47-3	Chromium	ug/L													
		7440-48-4	Cobalt	ug/L													
		7440-50-8	Copper	ug/L													
		7439-89-6	Iron	ug/L													
		7439-92-1	Lead	ug/L													
		7439-95-4	Magnesium	ug/L													
		7439-96-5	Manganese	ug/L													
		7440-02-0	Nickel	ug/L													
		7440-09-7	Potassium	ug/L													
		7782-49-2	Selenium	ug/L													
		7440-22-4	Silver	ug/L													
		7440-23-5	Sodium	ug/L													
		7440-28-0	Thallium	ug/L													
		7440-62-2	Vanadium	ug/L													
		7440-66-6	Zinc	ug/L													

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 1											Property 2			
				Sample ID: Sample Date:	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	OC-M24L54	Property 2(A)	Property 2(A)	Property 2(A)
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS		Chemical	Units													
Metals	T	7429-90-5	Aluminum	ug/L													200 U	
		7440-36-0	Antimony	ug/L													5 U	
		7440-38-2	Arsenic	ug/L													5 U	
		7440-39-3	Barium	ug/L													100 U	
		7440-41-7	Beryllium	ug/L													4 U	
		7440-43-9	Cadmium	ug/L													10 U	
		7440-70-2	Calcium	ug/L													52500	22400
		18540-29-9	Chromium, Hexavalent	ug/L	5 U	5 U	10 U	10 U	10 U	6 J	10 U	10 U	10 U	10 U				
		7440-47-3	Chromium	ug/L	2.2 J	0.63 J	0.62 J	0.6 J	10 U	10 U	0.71 J	10 U	10 U	0.56 J	15 U	30 U	30 U	
		7440-48-4	Cobalt	ug/L												50 U		
		7440-50-8	Copper	ug/L												36		
		7439-89-6	Iron	ug/L												41	52	
		7439-92-1	Lead	ug/L												5 U		
		7439-95-4	Magnesium	ug/L												5600	1970	
		7439-96-5	Manganese	ug/L												10 U	10 U	
		7439-97-6	Mercury	ug/L												0.5 U		
		7440-02-0	Nickel	ug/L												30 U		
		7440-09-7	Potassium	ug/L												2620	2600	
		7782-49-2	Selenium	ug/L												5 U		
7440-22-4	Silver	ug/L												20 U				
7440-23-5	Sodium	ug/L	29000	31000	31000	29000	30000	30000	29000	28000	29000	29000		38700	36600			
7440-28-0	Thallium	ug/L												5 U				
7440-62-2	Vanadium	ug/L												50 U				
7440-66-6	Zinc	ug/L												30				
Inorganics	T	16887-00-6	Chloride	ug/L	77,000	81,000	80,000	72,000	82,000	81,000	82,000	84,000	89,000	89,000	75,000	107,000	59,600	
		14797-55-8	Nitrate as N	ug/L	52 J	26 J	29 J	39 J	22 J	44 J	50 U	24 J	40 J	50 U		3250		
		14797-65-0	Nitrite as N	ug/L	50 UJ	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U		5 U		
		HLA0043	Nitrogen, as Ammonia	ug/L	250 U	250 U	160 J	250 U	200 U	230 U	130 J	220 U	280 U	130 J	100 U	500 U	660	
14808-79-8	Sulfate	ug/L	24,000	24,000	25,000	22,000	24,000	25,000	22,000	35,000	26,000	29,000	17,000	21,000	22,200			
Specialty	T	75-07-0	Acetaldehyde	ug/L														
		50-00-0	Formaldehyde	ug/L														
		302-01-2	Hydrazine	ug/L														
		123-77-3	Kempore (Azodicarbonamide)	ug/L														
		60-34-4	Monomethylhydrazine (MMH)	ug/L														
		101-25-7	OPEX	ug/L														
HLA0454	Phthalic Acid/Phthalic anhydride	ug/L																
57-14-7	UDMH	ug/L																
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L														
		506-12-7	Heptadecanoic Acid	ug/L														
		57-10-3	Hexadecanoic acid	ug/L														
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L														
		HLA0197	TIC Organic Acid(s)	ug/L			1.3 JN											
		HLA0141	TIC PAH(s)	ug/L														
HLA0058	TIC(s) Unspecified	ug/L	6.75 JN	3.26 JN	6.39 JN	0.38 JN			2.02 JN	3.13 JN	4.07 JN							
HLA0650	Unknown Hydrocarbons	ug/L							1.65 JN									

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
 if both results are ND, then the lower reporting limit is shown.
 if both results are detected, then the average of the detected values is shown.
 if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
 and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2												
			Sample ID:		Property 2 (A)	Property 2 - 24/94	Property 2 - 24/94 Dup	Property2 - 24/94 & Property 2 - 24/94 Dup	Property 2- 24/94	Property 2 - 24/94 & Property 2 - 24/94 Dup	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94
			Sample Date:		9/14/1999	2/2/2005					12/5/2008	3/18/2009	11/10/2009	7/8/2010	8/4/2010	9/29/2010	10/26/2010
			Sample Type:		FS	FS	FD	FS & FD	FS (8270 only)	Resolved (8270 all (1))	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units													
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L		1 U	1 U	1 U			0.5 U		1 U				
		71-55-6	1,1,1-Trichloroethane	ug/L		1 U	1 U	1 U			0.5 U		1 U				
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L		1 U	1 U	1 U			0.5 U		0.5 U				
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L									1 U				
		79-00-5	1,1,2-Trichloroethane	ug/L		1 U	1 U	1 U			0.5 U		1 U				
		75-34-3	1,1-Dichloroethane	ug/L		1 U	1 U	1 U			0.5 U		1 U				
		75-35-4	1,1-Dichloroethene	ug/L		1 U	1 U	1 U			0.5 UJ		1 U				
		563-58-6	1,1-Dichloropropene	ug/L		1 U	1 U	1 U			0.5 U		1 U				
		87-61-6	1,2,3-Trichlorobenzene	ug/L		1 U	1 U	1 U			0.5 U		1 U				
		96-18-4	1,2,3-Trichloropropane	ug/L		3 U	3 U	3 U			0.5 U		1 U				
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L								5.1 U	4.5 U				
		120-82-1	1,2,4-Trichlorobenzene	ug/L		1 U	1 U	1 U	1 U	10 U	1 U	0.5 U	5.1 U	1 U			
		95-63-6	1,2,4-Trimethylbenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L		5 U	5 U	5 U	5 U			0.5 UJ		5 U			
		106-93-4	1,2-Dibromoethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L		1 U	1 U	1 U	1 U					1 U			
		95-50-1	1,2-Dichlorobenzene (other)	ug/L						10 U		0.5 U	5.1 U				
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L							1 U						
		107-06-2	1,2-Dichloroethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		540-59-0	1,2-Dichloroethene (total)	ug/L													
		78-87-5	1,2-Dichloropropane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		108-67-8	1,3,5-Trimethylbenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		541-73-1	1,3-Dichlorobenzene	ug/L		1 U	1 U	1 U	1 U	10 U	1 U	0.5 U	5.1 U	1 U			
		142-28-9	1,3-Dichloropropane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		106-46-7	1,4-Dichlorobenzene	ug/L		1 U	1 U	1 U	1 U	10 U	1 U	0.5 U	5.1 U	1 U			
		123-91-1	1,4-Dioxane	ug/L		50 U	50 U	50 U	50 U					50 U			
		594-20-7	2,2-Dichloropropane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 UJ			
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L		1 U	1 U	1 U	1 U			1 U		1 U			
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L		1 U	1 U	1 U	1 U			1 U		1 U			
		78-93-3	2-Butanone	ug/L		10 U	10 U	10 U	10 U					10 U			
		95-49-8	2-Chlorotoluene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		591-78-6	2-Hexanone	ug/L		10 U	10 U	10 U	10 U					10 U			
		106-43-4	4-Chlorotoluene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		99-87-6	4-iso-Propyltoluene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		108-10-1	4-Methyl-2-pentanone	ug/L		10 U	10 U	10 U	10 U					10 U			
		79-20-9	Acetic acid, methyl ester	ug/L										10 U			
		67-64-1	Acetone	ug/L		50 U	50 U	50 U	50 U					50 U			
		71-43-2	Benzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		108-86-1	Bromobenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		74-97-5	Bromochloromethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		75-27-4	Bromodichloromethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		75-25-2	Bromoform	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		74-83-9	Bromomethane	ug/L		2 U	2 U	2 U	2 U			0.5 U		2 UJ			
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L		5 U	5 U	5 U	5 U					5 UJ			
		75-15-0	Carbon disulfide	ug/L		10 U	10 U	10 U	10 U					10 U			
		56-23-5	Carbon tetrachloride	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		108-90-7	Chlorobenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		75-00-3	Chloroethane	ug/L		2 U	2 U	2 U	2 U			0.5 U		2 U			
		67-66-3	Chloroform	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		74-87-3	Chloromethane	ug/L		2 U	2 U	2 U	2 U			0.5 UJ		2 U			
		156-59-2	Cis-1,2-Dichloroethene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		10061-01-5	Cis-1,3-Dichloropropene	ug/L		0.5 U	0.5 U	0.5 U	0.5 U			0.5 U		0.4 U			
		110-82-7	Cyclohexane	ug/L										10 U			
		124-48-1	Dibromochloromethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		0.5 U			
		74-95-3	Dibromomethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		75-71-8	Dichlorodifluoromethane	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		60-29-7	Diethyl ether	ug/L		1 U	1 U	1 U	1 U					10 U			
		637-92-3	Ethyl-t-Butyl Ether	ug/L		5 U	5 U	5 U	5 U					5 UJ			
		100-41-4	Ethylbenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		87-68-3	Hexachlorobutadiene	ug/L		0.6 U	0.6 U	0.6 U	0.6 U	10 U	0.6 U	0.5 U	0.4 U	0.4 U			
		108-20-3	Isopropyl ether	ug/L		5 U	5 U	5 U	5 U					10 U			
		98-82-8	Isopropylbenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		108-87-2	Methyl cyclohexane	ug/L										10 U			
		1634-04-4	Methyl Tertbutyl Ether	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			
		75-09-2	Methylene chloride	ug/L		2 U	2 U	2 U	2 U			0.5 U		2 U			
		104-51-8	n-Butylbenzene	ug/L		1 U	1 U	1 U	1 U			0.5 U		1 U			

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2												
			Sample ID:		Property 2(A)	Property 2 24/94	Property 2 24/94 Dup	Property 2 - 24/94 & 23 Property 2 - 24/94 Dup	Property 2 - 24/94	Property 2 - 24/94 & 2Property 2 - 24/94 Dup	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94
			Sample Date:		9/14/1999	2/2/2005					12/5/2008	3/18/2009	11/10/2009	7/8/2010	8/4/2010	9/29/2010	10/26/2010
			Sample Type:		FS	FS	FD	FS & FD	FS (8270 only)	Resolved (8270 all (1))	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units													
VOC	T	91-20-3	Naphthalene (8260)	ug/L		5 U	5 U	5 U				0.5 U	1 U	5 U			
		91-20-3	Naphthalene (other)	ug/L		1 U			5 U		1 U						
		91-20-3	Naphthalene (8260 & other)	ug/L						1 U							
		103-65-1	Propylbenzene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		135-98-8	sec-Butylbenzene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		100-42-5	Styrene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		98-06-6	tert-Butylbenzene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		127-18-4	Tetrachloroethene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		109-99-9	Tetrahydrofuran	ug/L		10 U	10 U	10 U						10 U			
		108-88-3	Toluene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		156-60-5	trans-1,2-Dichloroethene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		10061-02-6	trans-1,3-Dichloropropene	ug/L		0.5 U	0.5 U	0.5 U				0.5 U		0.4 U			
		79-01-6	Trichloroethene	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		75-69-4	Trichlorofluoromethane	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		108-05-4	Vinyl acetate	ug/L		10 U	10 U	10 U									
		75-01-4	Vinyl chloride	ug/L		1 U	1 U	1 U				0.5 U		0.5 U			
		95-47-6	Xylene, o	ug/L		1 U	1 U	1 U				0.5 U		1 U			
		179601-23-1	Xylenes (m&p)	ug/L		1 U	1 U	1 U				1 U		2 U			
		1330-20-7	Xylenes, Total	ug/L													
SVOC	T	90-12-0	1-Methylnaphthalene	ug/L		1 U							4.5 U				
		108-60-1	2,2'-Dichlorodisopropylether	ug/L								5.1 U	4.5 U				
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L									4.5 U				
		95-95-4	2,4,5-Trichlorophenol	ug/L					10 U			5.1 U	4.5 U				
		88-06-2	2,4,6-Trichlorophenol	ug/L					10 U			5.1 U	4.5 U				
		120-83-2	2,4-Dichlorophenol	ug/L					10 U			5.1 U	4.5 U				
		105-67-9	2,4-Dimethylphenol	ug/L					10 U			5.1 U	4.5 U				
		51-28-5	2,4-Dinitrophenol	ug/L					10 U			5.1 U	4.5 U				
		121-14-2	2,4-Dinitrotoluene	ug/L					10 U			5.1 U	4.5 U				
		606-20-2	2,6-Dinitrotoluene	ug/L					10 U			5.1 U	4.5 U				
		91-58-7	2-Chloronaphthalene	ug/L					10 U			5.1 U	4.5 U				
		95-57-8	2-Chlorophenol	ug/L					10 U			5.1 U	4.5 U				
		91-57-6	2-Methylnaphthalene	ug/L		1 U			5 U	1 U		1 U	0.91 U				
		95-48-7	2-Methylphenol	ug/L					10 U			5.1 U	4.5 U				
		88-74-4	2-Nitroaniline	ug/L					50 U			5.1 U	4.5 U				
		88-75-5	2-Nitrophenol	ug/L					10 U			5.1 U	4.5 U				
		15831-10-4	3 & 4 Methylphenol	ug/L					10 U			5.1 U	4.5 U				
		91-94-1	3,3'-Dichlorobenzidine	ug/L					20 U			5.1 U	4.5 U				
		108-39-4	3-Methylphenol	ug/L													
		99-09-2	3-Nitroaniline	ug/L					50 U			5.1 U	4.5 U				
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L					50 U			5.1 U	4.5 U				
		101-55-3	4-Bromophenyl phenyl ether	ug/L					10 U			5.1 U	4.5 U				
		59-50-7	4-Chloro-3-methylphenol	ug/L					20 U			5.1 U	4.5 U				
		106-47-8	4-Chloroaniline	ug/L					20 U			5.1 U	4.5 U				
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L					10 U			5.1 U	4.5 U				
		106-44-5	4-Methylphenol	ug/L													
		100-01-6	4-Nitroaniline	ug/L					50 U				4.5 U				
		100-02-7	4-Nitrophenol	ug/L					50 U			5.1 U	4.5 U				
		83-32-9	Acenaphthene	ug/L		1 U			5 U	1 U		1 U	0.91 U				
		208-96-8	Acenaphthylene	ug/L		1 U			5 U	1 U		0.3 U	0.27 U				
		98-86-2	Acetophenone	ug/L					10 U			5.1 U	4.5 U				
		309-00-2	Aldrin	ug/L													
		62-53-3	Aniline	ug/L					50 U			5.1 U	4.5 U				
		120-12-7	Anthracene	ug/L		1 U			5 U	1 U		1 U	0.91 U				
		1912-24-9	Atrazine	ug/L							0.2 U		4.5 U				
		103-33-3	Azobenzene	ug/L					10 U			5.1 U	4.5 U				
		100-52-7	Benzaldehyde	ug/L									4.5 U				
		56-55-3	Benzo(a)anthracene	ug/L		1 U			5 U	1 U		0.3 U	0.27 U				
		50-32-8	Benzo(a)pyrene	ug/L		0.2 U			5 U	0.2 U	0.2 U	0.2 U	0.18 U				
		205-99-2	Benzo(b)fluoranthene	ug/L		1 U			5 U	1 U		0.3 U	0.27 U				
		191-24-2	Benzo(ghi)perylene	ug/L		1 U			5 U	1 U		0.51 U	0.45 U				
		207-08-9	Benzo(k)fluoranthene	ug/L		1 U			5 U	1 U		0.3 U	0.27 U				
		65-85-0	Benzoic Acid	ug/L					50 U								
		100-51-6	Benzyl alcohol	ug/L					20 U					9.1 U			
		92-52-4	Biphenyl	ug/L										4.5 U			
		111-91-1	Bis(2-Chloroethoxy)methane	ug/L					10 U			5.1 U	4.5 U				
		111-44-4	Bis(2-Chloroethyl)ether	ug/L					10 U			5.1 U	4.5 U				
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L					10 U		2 U	2.9 U	1.8 U				
		85-68-7	Butylbenzylphthalate	ug/L					10 U			5.1 U	4.5 U				
		105-60-2	Caprolactam	ug/L									4.5 U				
		86-74-8	Carbazole	ug/L									4.5 U				
		12789-03-6	Chlordane (technical)	ug/L													
		218-01-9	Chrysene	ug/L		1 U			5 U	1 U		1 U	0.91 U				

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2											
			Sample ID:		Property 2(A)	Property 2 24/94	Property 2 - 24/94 Dup	Property 2 - 24/94 & Property 2 - 24/94 Dup	Property 2 - 24/94	Property 2 - 24/94 & Property 2 - 24/94 Dup	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94
			Sample Date:		9/14/1999			2/2/2005			12/5/2008	3/18/2009	11/10/2009	7/8/2010	8/4/2010	9/29/2010
			Sample Type:		FS	FS	FD	FS & FD	FS (8270 only)	Resolved (8270 all (1))	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units												
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L					10 U			5.1 U	4.5 U			
		117-84-0	Di-n-octylphthalate	ug/L					10 U			5.1 U	4.5 U			
		53-70-3	Dibenz(a,h)anthracene	ug/L		0.5 U			5 U	0.5 U		0.51 U	0.45 U			
		132-64-9	Dibenzofuran	ug/L					10 U			5.1 U	4.5 U			
		60-57-1	Dieldrin	ug/L												
		84-66-2	Diethylphthalate	ug/L					10 U			5.1 U	4.5 U			
		131-11-3	Dimethylphthalate	ug/L					10 U			5.1 U	4.5 U			
		101-84-8	Diphenyl ether	ug/L									4.5 U			
		119-61-9	Diphenylmethanone	ug/L									4.5 U			
		72-20-8	Endrin	ug/L									4.5 U			
		206-44-0	Fluoranthene	ug/L		1 U			5 U	1 U	0.51 U	1 U	0.91 U			
		86-73-7	Fluorene	ug/L		1 U			5 U	1 U		1 U	0.91 U			
		58-89-9	Gamma-BHC/Lindane	ug/L							0.2 U					
		1024-57-3	Heptachlor epoxide	ug/L							0.2 U					
		76-44-8	Heptachlor	ug/L							0.2 U					
		118-74-1	Hexachlorobenzene	ug/L					10 U		0.2 U	1 U	0.91 U			
		77-47-4	Hexachlorocyclopentadiene	ug/L					10 U		2 U		4.5 UJ			
		67-72-1	Hexachloroethane	ug/L					10 U			3 U	2.7 U			
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L		0.5 U			5 U	0.5 U		0.51 U	0.45 U			
		78-59-1	Isophorone	ug/L					10 U			5.1 U	4.5 U			
		72-43-5	Methoxychlor	ug/L							0.51 U					
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L					10 U							
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L								0.01 U	0.01 U	0.0096 UJ	0.0094 U	0.0089 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L												0.0019 U
		62-75-9	N-Nitrosodimethylamine	ug/L		0.002 UJ	0.0025 J	0.0025 J			0.014	0.002 U	0.0063	0.0019 UJ	0.031	0.017
		86-30-6	N-Nitrosodiphenylamine	ug/L					10 U				4.5 U			0.0041 J
		98-95-3	Nitrobenzene	ug/L					10 U			5.1 U	4.5 U			
		87-86-5	Pentachlorophenol	ug/L					50 U			1 U	0.91 U			
		85-01-8	Phenanthrene	ug/L		1 U			5 U	1 U		0.2 U	0.18 U			
		108-95-2	Phenol	ug/L					10 U			5.1 UJ	4.5 UJ			
		129-00-0	Pyrene	ug/L		1 U			5 U	1 U		5.1 U	4.5 U			
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L		50 U	50 U	50 U								
		HLA0156	C9-C10 Aromatics	ug/L		50 U	50 U	50 U								
		HLA0154	C9-C12 Aliphatics	ug/L		50 U	50 U	50 U								
Metals	D	7429-90-5	Aluminum	ug/L		100 U										
		7440-36-0	Antimony	ug/L		10 U										
		7440-38-2	Arsenic	ug/L		5 U										
		7440-43-9	Cadmium	ug/L		1 U										
		7440-70-2	Calcium	ug/L		24000	23000	23500								
		7440-47-3	Chromium	ug/L		10 U										
		7440-48-4	Cobalt	ug/L		20 U										
		7440-50-8	Copper	ug/L		40	38	39								
		7439-89-6	Iron	ug/L		50 U										
		7439-92-1	Lead	ug/L		5 U										
		7439-95-4	Magnesium	ug/L		1500	1400	1450								
		7439-96-5	Manganese	ug/L		10 U										
		7440-02-0	Nickel	ug/L		10 U										
		7440-09-7	Potassium	ug/L		2600 J	2400 J	2500 J								
		7782-49-2	Selenium	ug/L		2 U										
		7440-22-4	Silver	ug/L		5 U										
		7440-23-5	Sodium	ug/L		26000	26000	26000								
		7440-28-0	Thallium	ug/L		1 U										
		7440-62-2	Vanadium	ug/L		10 U										
		7440-66-6	Zinc	ug/L		50 U										

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2																		
		Property 2(A)			Property 2-24/94	Property 2-24/94 Dup	Property 2 - 24/94 & Property 2 - 24/94 Dup	Property 2 - 24/94	Property 2 - 24/94 & Property 2- 24/94 Dup	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94							
			Sample ID:	Sample Date:	9/14/1999	2/2/2005					12/5/2008	3/18/2009	11/10/2009	7/8/2010	8/4/2010	9/29/2010	10/26/2010						
			Sample Type:		FS	FS	FD	FS & FD	FS (8270 only)	Resolved (8270 all (1))	FS	FS	FS	FS	FS	FS	FS						
Chemical Class	Fraction	CAS	Chemical	Units																			
Metals	T	7429-90-5	Aluminum	ug/L	55000						29000		30000	35000 J	36000	43000	44000						
		7440-36-0	Antimony	ug/L																			
		7440-38-2	Arsenic	ug/L																			
		7440-39-3	Barium	ug/L																			
		7440-41-7	Beryllium	ug/L																			
		7440-43-9	Cadmium	ug/L																			
		7440-70-2	Calcium	ug/L																			
		18540-29-9	Chromium, Hexavalent	ug/L																			
		7440-47-3	Chromium	ug/L																			
		7440-48-4	Cobalt	ug/L																			
		7440-50-8	Copper	ug/L	10 U						5 U	5 U	5 U	5 U	5 U								
		7439-89-6	Iron	ug/L																			
		7439-92-1	Lead	ug/L																			
		7439-95-4	Magnesium	ug/L																			
		7439-96-5	Manganese	ug/L																			
		7439-97-6	Mercury	ug/L																			
		7440-02-0	Nickel	ug/L																			
		7440-09-7	Potassium	ug/L																			
		7782-49-2	Selenium	ug/L																			
		7440-22-4	Silver	ug/L																			
7440-23-5	Sodium	ug/L	2600	40000	26000	18000	18000	23000	20000														
7440-28-0	Thallium	ug/L																					
7440-62-2	Vanadium	ug/L																					
7440-66-6	Zinc	ug/L																					
Inorganics	T	16887-00-6								Chloride	ug/L	98,000	13,000	13,000	13,000		78,000		36,000	2,500	29,000	35,000	35,000
		14797-55-8								Nitrate as N	ug/L	2800	3000	3000	3000		1500		1000	700	670	400	330
		14797-65-0								Nitrite as N	ug/L	10 U	10 U	10 U	10 U		10 U		10 U	100 U	10 U	10 U	10 U
		HLA0043								Nitrogen, as Ammonia	ug/L	140	100 U		100 U		100 U		100 U	100 U	100 U	110	100 U
		14808-79-8								Sulfate	ug/L	20,000	25,000	24,000	24,500		17,000		21,000	24,000	24,000	29,000	29,000
Specialty	T	75-07-0								Acetaldehyde	ug/L		100 U	100 U	100 U			100 U	30 U				
		50-00-0	Formaldehyde	ug/L		50 U	50 U	50 U			50 U	30 U											
		302-01-2	Hydrazine	ug/L							0.05 U	0.2 U											
		123-77-3	Kempore (Azodicarbonamide)	ug/L		1000 U																	
		60-34-4	Monomethylhydrazine (MMH)	ug/L							0.25 U	0.5 U											
		101-25-7	OPEX	ug/L		100 U																	
		HLA0454	Phthalic Acid/Phthalic anhydride	ug/L																			
57-14-7	UDMH	ug/L							0.25 U	0.5 U													
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L																			
		506-12-7	Heptadecanoic Acid	ug/L																			
		57-10-3	Hexadecanoic acid	ug/L																			
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L																			
		HLA0197	TIC Organic Acid(s)	ug/L																			
		HLA0141	TIC PAH(s)	ug/L																			
		HLA0058	TIC(s) Unspecified	ug/L																			
HLA0650	Unknown Hydrocarbons	ug/L																					

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 2											
			Sample ID:	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94
			Sample Date:	12/17/2010	3/30/2011	7/12/2011	10/12/2011	2/28/2012	5/16/2012	10/9/2012	1/15/2013	3/18/2013	5/21/2013	9/11/2013	12/18/2013
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L											
		71-55-6	1,1,1-Trichloroethane	ug/L											
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L											
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L											
		79-00-5	1,1,2-Trichloroethane	ug/L											
		75-34-3	1,1-Dichloroethane	ug/L											
		75-35-4	1,1-Dichloroethene	ug/L											
		563-58-6	1,1-Dichloropropene	ug/L											
		87-61-6	1,2,3-Trichlorobenzene	ug/L											
		96-18-4	1,2,3-Trichloropropane	ug/L											
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L			4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U
		120-82-1	1,2,4-Trichlorobenzene	ug/L										4.9 U	
		95-63-6	1,2,4-Trimethylbenzene	ug/L											
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L											
		106-93-4	1,2-Dibromoethane	ug/L											
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L											
		95-50-1	1,2-Dichlorobenzene (other)	ug/L							0.96 U		4.9 U	4.9 U	4.8 U
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L											4.8 U
		107-06-2	1,2-Dichloroethane	ug/L											
		540-59-0	1,2-Dichloroethene (total)	ug/L											
		78-87-5	1,2-Dichloropropane	ug/L											
		108-67-8	1,3,5-Trimethylbenzene	ug/L											
		541-73-1	1,3-Dichlorobenzene	ug/L										4.9 U	
		142-28-9	1,3-Dichloropropane	ug/L											
		106-46-7	1,4-Dichlorobenzene	ug/L										4.9 U	
		123-91-1	1,4-Dioxane	ug/L											
		594-20-7	2,2-Dichloropropane	ug/L											
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L											
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L											
		78-93-3	2-Butanone	ug/L											
		95-49-8	2-Chlorotoluene	ug/L											
		591-78-6	2-Hexanone	ug/L											
		106-43-4	4-Chlorotoluene	ug/L											
		99-87-6	4-iso-Propyltoluene	ug/L											
		108-10-1	4-Methyl-2-pentanone	ug/L											
		79-20-9	Acetic acid, methyl ester	ug/L											
		67-64-1	Acetone	ug/L											
		71-43-2	Benzene	ug/L											
		108-86-1	Bromobenzene	ug/L											
		74-97-5	Bromochloromethane	ug/L											
		75-27-4	Bromodichloromethane	ug/L											
		75-25-2	Bromoform	ug/L											
		74-83-9	Bromomethane	ug/L											
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L											
		75-15-0	Carbon disulfide	ug/L											
		56-23-5	Carbon tetrachloride	ug/L											
		108-90-7	Chlorobenzene	ug/L											
		75-00-3	Chloroethane	ug/L											
		67-66-3	Chloroform	ug/L											
		74-87-3	Chloromethane	ug/L											
		156-59-2	Cis-1,2-Dichloroethene	ug/L											
		10061-01-5	Cis-1,3-Dichloropropene	ug/L											
		110-82-7	Cyclohexane	ug/L											
		124-48-1	Dibromochloromethane	ug/L											
		74-95-3	Dibromomethane	ug/L											
		75-71-8	Dichlorodifluoromethane	ug/L											
		60-29-7	Diethyl ether	ug/L											
		637-92-3	Ethyl-t-Butyl Ether	ug/L											
		100-41-4	Ethylbenzene	ug/L											
		87-68-3	Hexachlorobutadiene	ug/L											
		108-20-3	Isopropyl ether	ug/L										0.39 U	
		98-82-8	Isopropylbenzene	ug/L											
		108-87-2	Methyl cyclohexane	ug/L											
		1634-04-4	Methyl Tertbutyl Ether	ug/L											
		75-09-2	Methylene chloride	ug/L											
		104-51-8	n-Butylbenzene	ug/L											

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2													
			Sample ID:		OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	
			Sample Date:		12/17/2010	3/30/2011	7/12/2011	10/12/2011	2/28/2012	5/16/2012	10/9/2012	1/15/2013	3/18/2013	5/21/2013	9/11/2013	12/18/2013	2/18/2014	5/20/2014
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units														
VOC	T	91-20-3	Naphthalene (8260)	ug/L														
		91-20-3	Naphthalene (other)	ug/L												0.99 U		
		91-20-3	Naphthalene (8260 & other)	ug/L														
		103-65-1	Propylbenzene	ug/L														
		135-98-8	sec-Butylbenzene	ug/L														
		100-42-5	Styrene	ug/L														
		98-06-6	tert-Butylbenzene	ug/L														
		127-18-4	Tetrachloroethene	ug/L														
		109-99-9	Tetrahydrofuran	ug/L														
		108-88-3	Toluene	ug/L														
		156-60-5	trans-1,2-Dichloroethene	ug/L														
		10061-02-6	trans-1,3-Dichloropropene	ug/L														
		79-01-6	Trichloroethene	ug/L														
		75-69-4	Trichlorofluoromethane	ug/L														
		108-05-4	Vinyl acetate	ug/L														
		75-01-4	Vinyl chloride	ug/L														
		95-47-6	Xylene, o	ug/L														
		179601-23-1	Xylenes (m&p)	ug/L														
		1330-20-7	Xylenes, Total	ug/L														
SVOC	T	90-12-0	1-Methylnaphthalene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		108-60-1	2,2'-Dichlorodisopropylether	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 UJ	4.8 U	4.8 U
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		95-95-4	2,4,5-Trichlorophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		88-06-2	2,4,6-Trichlorophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		120-83-2	2,4-Dichlorophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		105-67-9	2,4-Dimethylphenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		51-28-5	2,4-Dinitrophenol	ug/L				4.9 UJ	4.8 UJ		4.8 U	0.96 U		4.9 U	4.9 U	4.8 UJ	4.8 U	4.8 U
		121-14-2	2,4-Dinitrotoluene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		606-20-2	2,6-Dinitrotoluene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		91-58-7	2-Chloronaphthalene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		95-57-8	2-Chlorophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		91-57-6	2-Methylnaphthalene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 UJ	0.96 U
		95-48-7	2-Methylphenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		88-74-4	2-Nitroaniline	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	4.8 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		88-75-5	2-Nitrophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		15831-10-4	3 & 4 Methylphenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		91-94-1	3,3'-Dichlorobenzidine	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	1.9 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		108-39-4	3-Methylphenol	ug/L														
		99-09-2	3-Nitroaniline	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	4.8 U		4.9 U	4.9 U	4.8 U	4.8 UJ	4.8 UJ
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L				4.9 UJ	4.8 U		4.9 U	4.8 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		101-55-3	4-Bromophenyl phenyl ether	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 UJ	4.8 U
		59-50-7	4-Chloro-3-methylphenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	1.9 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		106-47-8	4-Chloroaniline	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	1.9 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		106-44-5	4-Methylphenol	ug/L								0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		100-01-6	4-Nitroaniline	ug/L				4.9 UJ	4.8 U	4.7 UJ	4.8 U	4.8 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		100-02-7	4-Nitrophenol	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 UJ	4.8 U		4.9 U	4.9 U	4.8 UJ	4.8 UJ	4.8 UJ
		83-32-9	Acenaphthene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 U	0.96 U
		208-96-8	Acenaphthylene	ug/L				0.29 UJ	0.29 U	0.28 U	0.29 U	0.96 U		0.29 U	0.3 U	0.29 U	0.29 U	0.29 U
		98-86-2	Acetophenone	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		309-00-2	Aldrin	ug/L														
		62-53-3	Aniline	ug/L				4.9 UJ	4.8 UJ	4.7 U	4.8 UJ	0.96 U		4.9 U	4.9 U	4.8 U	4.8 UJ	4.8 U
		120-12-7	Anthracene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 UJ	0.96 U
		1912-24-9	Atrazine	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 UJ	4.8 U	4.8 U
		103-33-3	Azobenzene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 UJ	4.8 U
		100-52-7	Benzaldehyde	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	0.31 J	4.8 UJ	4.8 U
		56-55-3	Benzo(a)anthracene	ug/L				0.29 UJ	0.29 U	0.28 U	0.29 U	0.96 U		0.29 U	0.3 U	0.29 U	0.29 U	0.29 U
		50-32-8	Benzo(a)pyrene	ug/L				0.2 UJ	0.19 U	0.19 U	0.19 U	0.96 U		0.19 U	0.2 U	0.19 U	0.19 U	0.19 U
		205-99-2	Benzo(b)fluoranthene	ug/L				0.29 UJ	0.29 U	0.28 U	0.29 U	0.96 U		0.29 U	0.3 U	0.29 U	0.29 U	0.29 U
		191-24-2	Benzo(ghi)perylene	ug/L				0.49 UJ	0.51 U	0.47 U	0.48 U	0.96 U		0.49 U	0.49 U	0.48 U	0.48 U	0.48 UJ
		207-08-9	Benzo(k)fluoranthene	ug/L				0.29 UJ	0.29 U	0.28 U	0.29 U	0.96 U		0.29 U	0.3 U	0.29 U	0.29 U	0.29 U
		65-85-0	Benzoic Acid	ug/L				4.9 UJ	5.1 UJ	4.7 UJ	4.8 UJ	4.8 UJ		4.9 UJ				4.8 U
		100-51-6	Benzyl alcohol	ug/L				9.8 UJ	9.6 U	9.3 U	9.6 U	1.9 U		9.7 U	9.9 U	9.6 U	9.6 U	9.6 U
		92-52-4	Biphenyl	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		111-91-1	Bis(2-Chloroethoxy)methane	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		111-44-4	Bis(2-Chloroethyl)ether	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L				2 UJ	1.9 U	1.9 U	1.9 U	4.8 UJ		1.9 U	2 UJ	1.9 U	1.9 U	1.9 U
		85-68-7	Butylbenzylphthalate	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 U	4.8 U
		105-60-2	Caprolactam	ug/L				4.9 UJ	4.8 UJ		4.8 UJ	0.33 J		4.9 U	4.9 UJ	4.8 UJ	4.8 UJ	4.8 U
		86-74-8	Carbazole	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		4.9 U	4.9 U	4.8 U	4.8 UJ	4.8 U
		12789-03-6	Chlordane (technical)	ug/L														
		218-01-9	Chrysene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 U	0.96 U

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2													
			Sample ID:		OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	
			Sample Date:		12/17/2010	3/30/2011	7/12/2011	10/12/2011	2/28/2012	5/16/2012	10/9/2012	1/15/2013	3/18/2013	5/21/2013	9/11/2013	12/18/2013	2/18/2014	5/20/2014
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units														
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L				4.9 UJ	5.1 U	4.7 U	4.8 U	4.8 U		4.9 U	4.9 U	4.8 U	0.88 J	0.57 J
		117-84-0	Di-n-octylphthalate	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 UJ	4.9 U	4.9 UJ	4.8 U	4.8 U	4.8 U	
		53-70-3	Dibenz(a,h)anthracene	ug/L				0.49 UJ	0.51 U	0.47 U	0.48 U	0.96 U	0.49 U	0.49 U	0.48 U	0.48 U	0.48 UJ	
		132-64-9	Dibenzofuran	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	
		60-57-1	Dieldrin	ug/L														
		84-66-2	Diethylphthalate	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U		0.065 J	4.9 U	4.8 U	4.8 U	4.8 U
		131-11-3	Dimethylphthalate	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	
		101-84-8	Diphenyl ether	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 UJ	
		119-61-9	Diphenylmethanone	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	
		72-20-8	Endrin	ug/L														
		206-44-0	Fluoranthene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 UJ	0.96 U
		86-73-7	Fluorene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 U	0.96 U
		58-89-9	Gamma-BHC/Lindane	ug/L														
		1024-57-3	Heptachlor epoxide	ug/L														
		76-44-8	Heptachlor	ug/L														
		118-74-1	Hexachlorobenzene	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U		0.97 U	0.99 U	0.96 U	0.96 UJ	0.96 U
		77-47-4	Hexachlorocyclopentadiene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	1.9 U	4.9 UJ	4.9 UJ	4.8 U	4.8 U	4.8 U	
		67-72-1	Hexachloroethane	ug/L				2.9 UJ	2.9 U	2.8 U	2.9 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L				0.49 UJ	0.51 U	0.47 U	0.48 U	0.96 U	0.49 U	0.49 U	0.48 U	0.48 U	0.48 UJ	
		78-59-1	Isophorone	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	
		72-43-5	Methoxychlor	ug/L														
	621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L														4.8 U	
	621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 UJ	0.0019 U	0.0019 U	0.0034 U	0.0019 UJ	0.0019 U	0.0019 U	0.0019 U	0.0019 U	
	621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L														0.0019 U	
	62-75-9	N-Nitrosodimethylamine	ug/L	0.013	0.019 U	0.0019 U	0.004	0.0066	0.0069 J	0.033	0.0019 U	0.0021 U	0.0018 J	0.0019 U	0.0019 U	0.0021 U	0.00051 J	
	86-30-6	N-Nitrosodiphenylamine	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	4.8 U	
	98-95-3	Nitrobenzene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 UJ	4.8 U	4.8 U	
	87-86-5	Pentachlorophenol	ug/L				0.98 UJ	0.96 U	0.93 U	0.96 U	0.96 U	0.97 U	0.99 UJ	0.96 UJ	0.96 UJ	0.96 UJ	0.96 U	
	85-01-8	Phenanthrene	ug/L				0.2 UJ	0.19 U	0.19 U	0.38 U	0.96 U	0.39 U	0.39 U	0.38 U	0.088 J	0.39 U	0.39 U	
	108-95-2	Phenol	ug/L				4.9 UJ	4.8 U	4.7 UJ	4.8 UJ	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	4.8 U	
	129-00-0	Pyrene	ug/L				4.9 UJ	4.8 U	4.7 U	4.8 U	0.96 U	4.9 U	4.9 U	4.8 U	4.8 U	4.8 U	4.8 U	
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L														
		HLA0156	C9-C10 Aromatics	ug/L														
		HLA0154	C9-C12 Aliphatics	ug/L														
Metals	D	7429-90-5	Aluminum	ug/L														
		7440-36-0	Antimony	ug/L														
		7440-38-2	Arsenic	ug/L														
		7440-43-9	Cadmium	ug/L														
		7440-70-2	Calcium	ug/L														
		7440-47-3	Chromium	ug/L														
		7440-48-4	Cobalt	ug/L														
		7440-50-8	Copper	ug/L														
		7439-89-6	Iron	ug/L														
		7439-92-1	Lead	ug/L														
		7439-95-4	Magnesium	ug/L														
		7439-96-5	Manganese	ug/L														
		7440-02-0	Nickel	ug/L														
		7440-09-7	Potassium	ug/L														
		7782-49-2	Selenium	ug/L														
		7440-22-4	Silver	ug/L														
		7440-23-5	Sodium	ug/L														
		7440-28-0	Thallium	ug/L														
		7440-62-2	Vanadium	ug/L														
		7440-66-6	Zinc	ug/L														

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2																											
			Sample ID:		OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94															
			Sample Date:		12/17/2010	3/30/2011	7/12/2011	10/12/2011	2/28/2012	5/16/2012	10/9/2012	1/15/2013	3/18/2013	5/21/2013	9/11/2013	12/18/2013	2/18/2014	5/20/2014														
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS														
Chemical Class	Fraction	CAS	Chemical	Units																												
Metals	T	7429-90-5	Aluminum	ug/L	19000	20000	37000	0.73 J 5 U	1 U 5 U	1 U 5 U	1 J 5 U	5 U 5 U	1 U 5 U	5 U 5 U	67000 5 U 5 U	5 U 5 U	5 U 5 U	5 U 5 U														
		7440-36-0	Antimony	ug/L																												
		7440-38-2	Arsenic	ug/L																												
		7440-39-3	Barium	ug/L																												
		7440-41-7	Beryllium	ug/L																												
		7440-43-9	Cadmium	ug/L																												
		7440-70-2	Calcium	ug/L																												
		18540-29-9	Chromium, Hexavalent	ug/L																												
		7440-47-3	Chromium	ug/L																												
		7440-48-4	Cobalt	ug/L																												
		7440-50-8	Copper	ug/L																												
		7439-89-6	Iron	ug/L																												
		7439-92-1	Lead	ug/L																												
		7439-95-4	Magnesium	ug/L																												
		7439-96-5	Manganese	ug/L																												
		7439-97-6	Mercury	ug/L																												
		7440-02-0	Nickel	ug/L																												
		7440-09-7	Potassium	ug/L																												
		7782-49-2	Selenium	ug/L																												
7440-22-4	Silver	ug/L	23000	23000	49000	64000	29000	29000	30000	27000	76000	43000	37000	150000	76000																	
7440-23-5	Sodium	ug/L																														
7440-28-0	Thallium	ug/L																														
7440-62-2	Vanadium	ug/L																														
7440-66-6	Zinc	ug/L																														
Inorganics	T	16887-00-6	Chloride	ug/L	43,000	47,000	120,000	200,000	38,000	44,000	49,000 J	53,000	190,000 3900	120,000	130,000	320,000	170,000															
		14797-55-8	Nitrate as N	ug/L	1800	1700	1500	1300	1900	2000	1300	2200		550	260	4800	2200															
		14797-65-0	Nitrite as N	ug/L	10 U	100 U	100 U	100 UJ	10 U	10 U	100 U	50 U		50 U	50 U	50 U	50 U															
		HLA0043	Nitrogen, as Ammonia	ug/L	100 UJ	100 U	100 U	100 U	100 U	100 U	150	20 U		18 J	20 U	20 U	12 J	20 U														
		14808-79-8	Sulfate	ug/L	17,000	13,000	14,000	15,000	18,000	18,000	23,000	20,000		14,000	24,000	25,000	14,000	18,000														
Specialty	T	75-07-0	Acetaldehyde	ug/L																												
		50-00-0	Formaldehyde	ug/L																												
		302-01-2	Hydrazine	ug/L																												
		123-77-3	Kempore (Azodicarbonamide)	ug/L																												
		60-34-4	Monomethylhydrazine (MMH)	ug/L																												
		101-25-7	OPEX	ug/L																												
		HLA0454	Phthalic Acid/Phthalic anhydride	ug/L																												
57-14-7	UDMH	ug/L																														
TIC	T	2050-75-1	2,3-Dichloronaphthalene	ug/L																												
		506-12-7	Heptadecanoic Acid	ug/L																												
		57-10-3	Hexadecanoic Acid	ug/L																												
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L																												
		HLA0197	TIC Organic Acid(s)	ug/L																												
		HLA0141	TIC PAH(s)	ug/L																												
		HLA0058	TIC(s) Unspecified	ug/L																												
HLA0650	Unknown Hydrocarbons	ug/L																														

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 2											
			Sample ID:	OC-24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24 L94	OC-M24L94
			Sample Date:	9/10/2014	12/9/2014	3/25/2015	6/29/2015	9/29/2015	1/27/2016	3/23/2016	6/29/2016	9/29/2016	12/6/2016	1/4/2017	3/29/2017
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L											
		71-55-6	1,1,1-Trichloroethane	ug/L											
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L											
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L											
		79-00-5	1,1,2-Trichloroethane	ug/L											
		75-34-3	1,1-Dichloroethane	ug/L											
		75-35-4	1,1-Dichloroethene	ug/L											
		563-58-6	1,1-Dichloropropene	ug/L											
		87-61-6	1,2,3-Trichlorobenzene	ug/L											
		96-18-4	1,2,3-Trichloropropane	ug/L											
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ
		120-82-1	1,2,4-Trichlorobenzene	ug/L											
		95-63-6	1,2,4-Trimethylbenzene	ug/L											
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L											
		106-93-4	1,2-Dibromoethane	ug/L											
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L											
		95-50-1	1,2-Dichlorobenzene (other)	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L											
		107-06-2	1,2-Dichloroethane	ug/L											
		540-59-0	1,2-Dichloroethene (total)	ug/L											
		78-87-5	1,2-Dichloropropane	ug/L											
		108-67-8	1,3,5-Trimethylbenzene	ug/L											
		541-73-1	1,3-Dichlorobenzene	ug/L											
		142-28-9	1,3-Dichloropropane	ug/L											
		106-46-7	1,4-Dichlorobenzene	ug/L											
		123-91-1	1,4-Dioxane	ug/L											
		594-20-7	2,2-Dichloropropane	ug/L											
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L											
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L											
		78-93-3	2-Butanone	ug/L											
		95-49-8	2-Chlorotoluene	ug/L											
		591-78-6	2-Hexanone	ug/L											
		106-43-4	4-Chlorotoluene	ug/L											
		99-87-6	4-iso-Propyltoluene	ug/L											
		108-10-1	4-Methyl-2-pentanone	ug/L											
		79-20-9	Acetic acid, methyl ester	ug/L											
		67-64-1	Acetone	ug/L											
		71-43-2	Benzene	ug/L											
		108-86-1	Bromobenzene	ug/L											
		74-97-5	Bromochloromethane	ug/L											
		75-27-4	Bromodichloromethane	ug/L											
		75-25-2	Bromoform	ug/L											
		74-83-9	Bromomethane	ug/L											
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L											
		75-15-0	Carbon disulfide	ug/L											
		56-23-5	Carbon tetrachloride	ug/L											
		108-90-7	Chlorobenzene	ug/L											
		75-00-3	Chloroethane	ug/L											
		67-66-3	Chloroform	ug/L											
		74-87-3	Chloromethane	ug/L											
		156-59-2	Cis-1,2-Dichloroethene	ug/L											
		10061-01-5	Cis-1,3-Dichloropropene	ug/L											
		110-82-7	Cyclohexane	ug/L											
		124-48-1	Dibromochloromethane	ug/L											
		74-95-3	Dibromomethane	ug/L											
		75-71-8	Dichlorodifluoromethane	ug/L											
		60-29-7	Diethyl ether	ug/L											
		637-92-3	Ethyl-t-Butyl Ether	ug/L											
		100-41-4	Ethylbenzene	ug/L											
		87-68-3	Hexachlorobutadiene	ug/L											
		108-20-3	Isopropyl ether	ug/L											
		98-82-8	Isopropylbenzene	ug/L											
		108-87-2	Methyl cyclohexane	ug/L											
		1634-04-4	Methyl Tertbutyl Ether	ug/L											
		75-09-2	Methylene chloride	ug/L											
		104-51-8	n-Butylbenzene	ug/L											

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 2													
			Sample ID:	OC-24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24 L94	OC-M24L94
			Sample Date:	9/10/2014	12/9/2014	3/25/2015	6/29/2015	9/29/2015	1/27/2016	3/23/2016	6/29/2016	9/29/2016	12/6/2016	1/4/2017	3/29/2017	6/22/2017	8/3/2017
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units													
VOC	T	91-20-3	Naphthalene (8260)	ug/L													
		91-20-3	Naphthalene (other)	ug/L													
		91-20-3	Naphthalene (8260 & other)	ug/L													
		103-65-1	Propylbenzene	ug/L													
		135-98-8	sec-Butylbenzene	ug/L													
		100-42-5	Styrene	ug/L													
		98-06-6	tert-Butylbenzene	ug/L													
		127-18-4	Tetrachloroethene	ug/L													
		109-99-9	Tetrahydrofuran	ug/L													
		108-88-3	Toluene	ug/L													
		156-60-5	trans-1,2-Dichloroethene	ug/L													
		10061-02-6	trans-1,3-Dichloropropene	ug/L													
		79-01-6	Trichloroethene	ug/L													
		75-69-4	Trichlorofluoromethane	ug/L													
		108-05-4	Vinyl acetate	ug/L													
		75-01-4	Vinyl chloride	ug/L													
		95-47-6	Xylene, o	ug/L													
		179601-23-1	Xylenes (m&p)	ug/L													
		1330-20-7	Xylenes, Total	ug/L													
SVOC	T	90-12-0	1-Methylnaphthalene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		108-60-1	2,2'-Dichlorodisopropylether	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L	9.5 UJ	9.5 U	9.5 U	9.6 U	9.5 U	9.5 U	9.5 U	9.6 U		9.5 U	9.6 UJ	9.5 U	
		95-95-4	2,4,5-Trichlorophenol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		88-06-2	2,4,6-Trichlorophenol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		120-83-2	2,4-Dichlorophenol	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		105-67-9	2,4-Dimethylphenol	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		51-28-5	2,4-Dinitrophenol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		121-14-2	2,4-Dinitrotoluene	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		606-20-2	2,6-Dinitrotoluene	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		91-58-7	2-Chloronaphthalene	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		95-57-8	2-Chlorophenol	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		91-57-6	2-Methylnaphthalene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		95-48-7	2-Methylphenol	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		88-74-4	2-Nitroaniline	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		88-75-5	2-Nitrophenol	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		15831-10-4	3 & 4 Methylphenol	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		91-94-1	3,3'-Dichlorobenzidine	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		108-39-4	3-Methylphenol	ug/L													
		99-09-2	3-Nitroaniline	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		101-55-3	4-Bromophenyl phenyl ether	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		59-50-7	4-Chloro-3-methylphenol	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		106-47-8	4-Chloroaniline	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		106-44-5	4-Methylphenol	ug/L													
		100-01-6	4-Nitroaniline	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		100-02-7	4-Nitrophenol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		83-32-9	Acenaphthene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		208-96-8	Acenaphthylene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		98-86-2	Acetophenone	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		309-00-2	Aldrin	ug/L													
		62-53-3	Aniline	ug/L	4.8 UJ	4.8 U	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		120-12-7	Anthracene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		1912-24-9	Atrazine	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		103-33-3	Azobenzene	ug/L	9.5 UJ	9.5 U	9.5 U	9.6 U	9.5 U	9.5 U	9.5 U	9.6 U		9.5 U	9.6 UJ	9.5 U	
		100-52-7	Benzaldehyde	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		56-55-3	Benzo(a)anthracene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		50-32-8	Benzo(a)pyrene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		205-99-2	Benzo(b)fluoranthene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		191-24-2	Benzo(ghi)perylene	ug/L	0.19 UJ	0.19 U	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		207-08-9	Benzo(k)fluoranthene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	
		65-85-0	Benzoic Acid	ug/L		24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ	24 UJ		24 UJ	24 UJ		
		100-51-6	Benzyl alcohol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		92-52-4	Biphenyl	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		111-91-1	Bis(2-Chloroethoxy)methane	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		111-44-4	Bis(2-Chloroethyl)ether	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U	
		85-68-7	Butylbenzylphthalate	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U	
		105-60-2	Caprolactam	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 UJ	4.8 U	4.8 UJ	4.8 UJ	0.22 J		4.8 UJ	4.8 UJ	0.32 J	
		86-74-8	Carbazole	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U	
		12789-03-6	Chlordane (technical)	ug/L													
		218-01-9	Chrysene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U	

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2														
			Sample ID:		OC-24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24 L94	OC-M24L94		
			Sample Date:		9/10/2014	12/9/2014	3/25/2015	6/29/2015	9/29/2015	1/27/2016	3/23/2016	6/29/2016	9/29/2016	12/6/2016	1/4/2017	3/29/2017	6/22/2017	8/3/2017	
			Sample Type:		FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units															
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 UJ			
		117-84-0	Di-n-octylphthalate	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U			
		53-70-3	Dibenz(a,h)anthracene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U			
		132-64-9	Dibenzofuran	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.95 U		0.95 U	0.96 UJ	0.95 U			
		60-57-1	Dieldrin	ug/L															
		84-66-2	Diethylphthalate	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U			
		131-11-3	Dimethylphthalate	ug/L	1.9 UJ	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U		1.9 U	1.9 UJ	1.9 U			
		101-84-8	Diphenyl ether	ug/L	9.5 UJ	9.5 U	9.5 U	9.6 U	9.5 U	9.5 U	9.5 U	9.5 U		9.5 U	9.6 UJ	9.5 U			
		119-61-9	Diphenylmethanone	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U			
		72-20-8	Endrin	ug/L															
		206-44-0	Fluoranthene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U			
		86-73-7	Fluorene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U			
		58-89-9	Gamma-BHC/Lindane	ug/L															
		1024-57-3	Heptachlor epoxide	ug/L															
		76-44-8	Heptachlor	ug/L															
		118-74-1	Hexachlorobenzene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U			
		77-47-4	Hexachlorocyclopentadiene	ug/L	9.5 UJ	9.5 U	9.5 U	9.6 U	9.5 U	9.5 U	9.5 UJ	9.6 U		9.5 U	9.6 UJ	9.5 U			
		67-72-1	Hexachloroethane	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U			
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U			
		78-59-1	Isophorone	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U			
		72-43-5	Methoxychlor	ug/L															
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.0029 J	0.0019 UJ	0.0019 U	0.0019 U		0.0019 U	0.0019 UJ	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U								
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U								
		62-75-9	N-Nitrosodimethylamine	ug/L	0.0089	0.0051	0.001 J	0.013	0.0014 J	0.0046 J	0.00087 J	0.0055	0.0019 U	0.0019 U		0.0019 U		0.056	
		86-30-6	N-Nitrosodiphenylamine	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U		
		98-95-3	Nitrobenzene	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 U	0.96 UJ	0.95 U		
		87-86-5	Pentachlorophenol	ug/L	4.8 UJ	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U	4.8 U		4.8 U	4.8 UJ	4.8 U		
		85-01-8	Phenanthrene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U		
		108-95-2	Phenol	ug/L	0.95 UJ	0.95 U	0.95 U	0.96 U	0.95 U	0.95 U	0.95 U	0.95 U	0.96 U		0.95 UJ	0.96 UJ	0.95 U		
		129-00-0	Pyrene	ug/L	0.19 UJ	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U		0.19 U	0.19 UJ	0.19 U		
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L															
		HLA0156	C9-C10 Aromatics	ug/L															
		HLA0154	C9-C12 Aliphatics	ug/L															
Metals	D	7429-90-5	Aluminum	ug/L															
		7440-36-0	Antimony	ug/L															
		7440-38-2	Arsenic	ug/L															
		7440-43-9	Cadmium	ug/L															
		7440-70-2	Calcium	ug/L															
		7440-47-3	Chromium	ug/L															
		7440-48-4	Cobalt	ug/L															
		7440-50-8	Copper	ug/L															
		7439-89-6	Iron	ug/L															
		7439-92-1	Lead	ug/L															
		7439-95-4	Magnesium	ug/L															
		7439-96-5	Manganese	ug/L															
		7440-02-0	Nickel	ug/L															
		7440-09-7	Potassium	ug/L															
		7782-49-2	Selenium	ug/L															
		7440-22-4	Silver	ug/L															
		7440-23-5	Sodium	ug/L															
		7440-28-0	Thallium	ug/L															
		7440-62-2	Vanadium	ug/L															
		7440-66-6	Zinc	ug/L															

Attachment A
Table A-1
Analytical Data: Private Wells used for Potable Purposes at Residential Properties, Property 1 and Property 2

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:	Property 2											
			Sample ID:	OC-24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24L94	OC-M24 L94	OC-M24L94
			Sample Date:	9/10/2014	12/9/2014	3/25/2015	6/29/2015	9/29/2015	1/27/2016	3/23/2016	6/29/2016	9/29/2016	12/6/2016	1/4/2017	3/29/2017
			Sample Type:	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
Chemical Class	Fraction	CAS	Chemical	Units											
Metals	T	7429-90-5	Aluminum	ug/L											
		7440-36-0	Antimony	ug/L											
		7440-38-2	Arsenic	ug/L											
		7440-39-3	Barium	ug/L											
		7440-41-7	Beryllium	ug/L											
		7440-43-9	Cadmium	ug/L											
		7440-70-2	Calcium	ug/L											
		18540-29-9	Chromium, Hexavalent	ug/L	5 U	5 U	5 U	5 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
		7440-47-3	Chromium	ug/L	5 U	0.62 J	10 U	0.99 J	1.1 J	10 U	0.78 J	0.86 J	0.78 J		
		7440-48-4	Cobalt	ug/L											
		7440-50-8	Copper	ug/L											
		7439-89-6	Iron	ug/L											
		7439-92-1	Lead	ug/L											
		7439-95-4	Magnesium	ug/L											
		7439-96-5	Manganese	ug/L											
		7439-97-6	Mercury	ug/L											
		7440-02-0	Nickel	ug/L											
		7440-09-7	Potassium	ug/L											
		7782-49-2	Selenium	ug/L											
Inorganics	T	7440-22-4	Silver	ug/L											
		7440-23-5	Sodium	ug/L	61000	120000	59000	55000	54000	49000	45000	59000	35000	26000	33000
		7440-28-0	Thallium	ug/L											
		7440-62-2	Vanadium	ug/L											
		7440-66-6	Zinc	ug/L											
		16887-00-6	Chloride	ug/L	180,000	280,000	110,000	92,000	140,000	84,000	82,000	110,000	120,000	110,000	100,000
		14797-55-8	Nitrate as N	ug/L	1100	2000	2200	1300 J	650	2400	2200	2500	360	230	740
		14797-65-0	Nitrite as N	ug/L	50 U	250 U	100 U	50 UJ	50 U	250 U	50 U	50 U	50 U	50 U	50 U
		HLA0043	Nitrogen, as Ammonia	ug/L	20 U	130	250 U	250 U	250 U	250 U	250 U	200 U	220 U	110 J	330 U
		14808-79-8	Sulfate	ug/L	20,000	18,000	18,000	18,000	22,000	18,000	18,000	20,000	24,000	17,000	22,000
Specialty	T	75-07-0	Acetaldehyde	ug/L											
		50-00-0	Formaldehyde	ug/L											
		302-01-2	Hydrazine	ug/L											
		123-77-3	Kempore (Azodicarbonamide)	ug/L											
		60-34-4	Monomethylhydrazine (MMH)	ug/L											
		101-25-7	OPEX	ug/L											
		HLA0454	Phthalic Acid/Phthalic anhydride	ug/L											
TIC	T	57-14-7	UDMH	ug/L											
		2050-75-1	2,3-Dichloronaphthalene	ug/L						0.78 JN					
		506-12-7	Heptadecanoic Acid	ug/L											
		57-10-3	Hexadecanoic acid	ug/L			0.76 JN								
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L			0.94 JN								
		HLA0197	TIC Organic Acid(s)	ug/L											
		HLA0141	TIC PAH(s)	ug/L			0.81 JN		0.84 JN					2 JN	
		HLA0058	TIC(s) Unspecified	ug/L			2.5 JN	2.91 JN	1.19 JN	3.6 JN	2.19 JN	1.7 JN		19.3 JN	
		HLA0650	Unknown Hydrocarbons	ug/L			0.95 JN				4.26 JN		0.51 JN		1.1 JN

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identified Compounds
Fraction: T: Total, D: Dissolved
(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2	
			Sample ID:	OC-M24L94	OC-M24L94	
			Sample Date:	8/24/2017	9/28/2017	
			Sample Type:	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units		
VOC	T	630-20-6	1,1,1,2-Tetrachloroethane	ug/L	0.95 U	
		71-55-6	1,1,1-Trichloroethane	ug/L		
		79-34-5	1,1,2,2-Tetrachloroethane	ug/L		
		76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L		
		79-00-5	1,1,2-Trichloroethane	ug/L		
		75-34-3	1,1-Dichloroethane	ug/L		
		75-35-4	1,1-Dichloroethene	ug/L		
		563-58-6	1,1-Dichloropropene	ug/L		
		87-61-6	1,2,3-Trichlorobenzene	ug/L		
		96-18-4	1,2,3-Trichloropropane	ug/L		
		95-94-3	1,2,4,5-Tetrachlorobenzene	ug/L		
		120-82-1	1,2,4-Trichlorobenzene	ug/L		
		95-63-6	1,2,4-Trimethylbenzene	ug/L		
		96-12-8	1,2-Dibromo-3-chloropropane	ug/L		
		106-93-4	1,2-Dibromoethane	ug/L		
		95-50-1	1,2-Dichlorobenzene (8260)	ug/L	0.95 U	
		95-50-1	1,2-Dichlorobenzene (other)	ug/L		
		95-50-1	1,2-Dichlorobenzene (8260 & other)	ug/L		
		107-06-2	1,2-Dichloroethane	ug/L		
		540-59-0	1,2-Dichloroethene (total)	ug/L		
		78-87-5	1,2-Dichloropropane	ug/L		
		108-67-8	1,3,5-Trimethylbenzene	ug/L		
		541-73-1	1,3-Dichlorobenzene	ug/L		
		142-28-9	1,3-Dichloropropane	ug/L		
		106-46-7	1,4-Dichlorobenzene	ug/L		
		123-91-1	1,4-Dioxane	ug/L		
		594-20-7	2,2-Dichloropropane	ug/L		
		107-39-1	2,4,4-Trimethyl-1-pentene	ug/L		
		107-40-4	2,4,4-Trimethyl-2-pentene	ug/L		
		78-93-3	2-Butanone	ug/L		
		95-49-8	2-Chlorotoluene	ug/L		
		591-78-6	2-Hexanone	ug/L		
		106-43-4	4-Chlorotoluene	ug/L		
		99-87-6	4-iso-Propyltoluene	ug/L		
		108-10-1	4-Methyl-2-pentanone	ug/L		
		79-20-9	Acetic acid, methyl ester	ug/L		
		67-64-1	Acetone	ug/L		
		71-43-2	Benzene	ug/L		
		108-86-1	Bromobenzene	ug/L		
		74-97-5	Bromochloromethane	ug/L		
		75-27-4	Bromodichloromethane	ug/L		
		75-25-2	Bromoform	ug/L		
		74-83-9	Bromomethane	ug/L		
		994-05-8	Butane, 2-methoxy-2-methyl-	ug/L		
		75-15-0	Carbon disulfide	ug/L		
		56-23-5	Carbon tetrachloride	ug/L		
		108-90-7	Chlorobenzene	ug/L		
		75-00-3	Chloroethane	ug/L		
		67-66-3	Chloroform	ug/L		
		74-87-3	Chloromethane	ug/L		
		156-59-2	Cis-1,2-Dichloroethene	ug/L		
		10061-01-5	Cis-1,3-Dichloropropene	ug/L		
		110-82-7	Cyclohexane	ug/L		
		124-48-1	Dibromochloromethane	ug/L		
		74-95-3	Dibromomethane	ug/L		
		75-71-8	Dichlorodifluoromethane	ug/L		
		60-29-7	Diethyl ether	ug/L		
		637-92-3	Ethyl-t-Butyl Ether	ug/L		
		100-41-4	Ethylbenzene	ug/L		
		87-68-3	Hexachlorobutadiene	ug/L		
		108-20-3	Isopropyl ether	ug/L		
		98-82-8	Isopropylbenzene	ug/L		
		108-87-2	Methyl cyclohexane	ug/L		
		1634-04-4	Methyl Tertbutyl Ether	ug/L		
		75-09-2	Methylene chloride	ug/L		
		104-51-8	n-Butylbenzene	ug/L		

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2	
			Sample ID:	OC-M24L94	OC-M24L94	
			Sample Date:	8/24/2017	9/28/2017	
			Sample Type:	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units		
VOC	T	91-20-3	Naphthalene (8260)	ug/L		
		91-20-3	Naphthalene (other)	ug/L		
		91-20-3	Naphthalene (8260 & other)	ug/L		
		103-65-1	Propylbenzene	ug/L		
		135-98-8	sec-Butylbenzene	ug/L		
		100-42-5	Styrene	ug/L		
		98-06-6	tert-Butylbenzene	ug/L		
		127-18-4	Tetrachloroethene	ug/L		
		109-99-9	Tetrahydrofuran	ug/L		
		108-88-3	Toluene	ug/L		
		156-60-5	trans-1,2-Dichloroethene	ug/L		
		10061-02-6	trans-1,3-Dichloropropene	ug/L		
		79-01-6	Trichloroethene	ug/L		
		75-69-4	Trichlorofluoromethane	ug/L		
		108-05-4	Vinyl acetate	ug/L		
		75-01-4	Vinyl chloride	ug/L		
		95-47-6	Xylene, o	ug/L		
		179601-23-1	Xylenes (m&p)	ug/L		
SVOC	T	1330-20-7	Xylenes, Total	ug/L		
		90-12-0	1-Methylnaphthalene	ug/L		0.19 U
		108-60-1	2,2'-Dichlorodiisopropylether	ug/L		0.95 U
		58-90-2	2,3,4,6-Tetrachlorophenol	ug/L		9.5 U
		95-95-4	2,4,5-Trichlorophenol	ug/L		4.8 U
		88-06-2	2,4,6-Trichlorophenol	ug/L		4.8 U
		120-83-2	2,4-Dichlorophenol	ug/L		1.9 U
		105-67-9	2,4-Dimethylphenol	ug/L		1.9 U
		51-28-5	2,4-Dinitrophenol	ug/L		4.8 U
		121-14-2	2,4-Dinitrotoluene	ug/L		4.8 U
		606-20-2	2,6-Dinitrotoluene	ug/L		4.8 U
		91-58-7	2-Chloronaphthalene	ug/L		0.95 U
		95-57-8	2-Chlorophenol	ug/L		0.95 U
		91-57-6	2-Methylnaphthalene	ug/L		0.19 U
		95-48-7	2-Methylphenol	ug/L		0.95 U
		88-74-4	2-Nitroaniline	ug/L		1.9 U
		88-75-5	2-Nitrophenol	ug/L		1.9 U
		15831-10-4	3 & 4 Methylphenol	ug/L		1.9 U
		91-94-1	3,3'-Dichlorobenzidine	ug/L		4.8 U
		108-39-4	3-Methylphenol	ug/L		
		99-09-2	3-Nitroaniline	ug/L		1.9 U
		534-52-1	4,6-Dinitro-2-methylphenol	ug/L		4.8 U
		101-55-3	4-Bromophenyl phenyl ether	ug/L		1.9 U
		59-50-7	4-Chloro-3-methylphenol	ug/L		1.9 U
		106-47-8	4-Chloroaniline	ug/L		1.9 U
		7005-72-3	4-Chlorophenyl phenyl ether	ug/L		1.9 U
		106-44-5	4-Methylphenol	ug/L		
		100-01-6	4-Nitroaniline	ug/L		1.9 U
		100-02-7	4-Nitrophenol	ug/L		4.8 U
		83-32-9	Acenaphthene	ug/L		0.19 U
		208-96-8	Acenaphthylene	ug/L		0.19 U
		98-86-2	Acetophenone	ug/L		0.95 U
		309-00-2	Aldrin	ug/L		
		62-53-3	Aniline	ug/L		4.8 U
		120-12-7	Anthracene	ug/L		0.19 U
		1912-24-9	Atrazine	ug/L		1.9 U
		103-33-3	Azobenzene	ug/L		9.5 U
		100-52-7	Benzaldehyde	ug/L		1.9 U
		56-55-3	Benzo(a)anthracene	ug/L		0.19 U
		50-32-8	Benzo(a)pyrene	ug/L		0.19 U
		205-99-2	Benzo(b)fluoranthene	ug/L		0.19 U
		191-24-2	Benzo(ghi)perylene	ug/L		0.19 U
		207-08-9	Benzo(k)fluoranthene	ug/L		0.19 U
		65-85-0	Benzoic Acid	ug/L		24 UJ
		100-51-6	Benzyl alcohol	ug/L		4.8 U
		92-52-4	Biphenyl	ug/L		0.95 U
		111-91-1	Bis(2-Chloroethoxy)methane	ug/L		0.95 U
		111-44-4	Bis(2-Chloroethyl)ether	ug/L		0.95 U
		117-81-7	Bis(2-Ethylhexyl)phthalate	ug/L		4.8 U
		85-68-7	Butylbenzylphthalate	ug/L		1.9 U
		105-60-2	Caprolactam	ug/L		4.8 UJ
		86-74-8	Carbazole	ug/L		0.95 U
		12789-03-6	Chlordane (technical)	ug/L		
		218-01-9	Chrysene	ug/L		0.19 U

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2	
			Sample ID:	OC-M24L94	OC-M24L94	
			Sample Date:	8/24/2017	9/28/2017	
			Sample Type:	FS	FS	
Chemical Class	Fraction	CAS	Chemical	Units		
SVOC	T	84-74-2	Di-n-butylphthalate	ug/L		4.8 U
		117-84-0	Di-n-octylphthalate	ug/L		1.9 U
		53-70-3	Dibenz(a,h)anthracene	ug/L		0.19 U
		132-64-9	Dibenzofuran	ug/L		0.95 U
		60-57-1	Dieldrin	ug/L		
		84-66-2	Diethylphthalate	ug/L		1.9 U
		131-11-3	Dimethylphthalate	ug/L		1.9 U
		101-84-8	Diphenyl ether	ug/L		9.5 U
		119-61-9	Diphenylmethanone	ug/L		4.8 U
		72-20-8	Endrin	ug/L		
		206-44-0	Fluoranthene	ug/L		0.19 U
		86-73-7	Fluorene	ug/L		0.19 U
		58-89-9	Gamma-BHC/Lindane	ug/L		
		1024-57-3	Heptachlor epoxide	ug/L		
		76-44-8	Heptachlor	ug/L		
		118-74-1	Hexachlorobenzene	ug/L		0.19 U
		77-47-4	Hexachlorocyclopentadiene	ug/L		9.5 U
		67-72-1	Hexachloroethane	ug/L		0.95 U
		193-39-5	Indeno(1,2,3-cd)pyrene	ug/L		0.19 U
		78-59-1	Isophorone	ug/L		0.95 U
		72-43-5	Methoxychlor	ug/L		
		621-64-7	N-Nitrosodi-n-propylamine (8270)	ug/L		
		621-64-7	N-Nitrosodi-n-propylamine (other)	ug/L	0.0019 U	0.0019 U
		621-64-7	N-Nitrosodi-n-propylamine (8270 & other (2))	ug/L		
		62-75-9	N-Nitrosodimethylamine	ug/L	0.0019 U	0.0029
		86-30-6	N-Nitrosodiphenylamine	ug/L		0.95 U
		98-95-3	Nitrobenzene	ug/L		0.95 U
		87-86-5	Pentachlorophenol	ug/L		4.8 U
		85-01-8	Phenanthrene	ug/L		0.19 U
		108-95-2	Phenol	ug/L		0.95 U
		129-00-0	Pyrene	ug/L		0.19 U
VPH	T	HLA0155	C5-C8 Aliphatics	ug/L		
		HLA0156	C9-C10 Aromatics	ug/L		
		HLA0154	C9-C12 Aliphatics	ug/L		
Metals	D	7429-90-5	Aluminum	ug/L		
		7440-36-0	Antimony	ug/L		
		7440-38-2	Arsenic	ug/L		
		7440-43-9	Cadmium	ug/L		
		7440-70-2	Calcium	ug/L		
		7440-47-3	Chromium	ug/L		
		7440-48-4	Cobalt	ug/L		
		7440-50-8	Copper	ug/L		
		7439-89-6	Iron	ug/L		
		7439-92-1	Lead	ug/L		
		7439-95-4	Magnesium	ug/L		
		7439-96-5	Manganese	ug/L		
		7440-02-0	Nickel	ug/L		
		7440-09-7	Potassium	ug/L		
		7782-49-2	Selenium	ug/L		
		7440-22-4	Silver	ug/L		
		7440-23-5	Sodium	ug/L		
		7440-28-0	Thallium	ug/L		
		7440-62-2	Vanadium	ug/L		
		7440-66-6	Zinc	ug/L		

Human Health Risk Assessment
Olin OU3
Wilmington, MA

			Location:		Property 2	
			Sample ID:		OC-M24L94	OC-M24L94
			Sample Date:		8/24/2017	9/28/2017
			Sample Type:		FS	FS
Chemical Class	Fraction	CAS	Chemical	Units		
Metals	T	7429-90-5	Aluminum	ug/L		
		7440-36-0	Antimony	ug/L		
		7440-38-2	Arsenic	ug/L		
		7440-39-3	Barium	ug/L		
		7440-41-7	Beryllium	ug/L		
		7440-43-9	Cadmium	ug/L		
		7440-70-2	Calcium	ug/L		
		18540-29-9	Chromium, Hexavalent	ug/L		10 U
		7440-47-3	Chromium	ug/L		10 U
		7440-48-4	Cobalt	ug/L		
		7440-50-8	Copper	ug/L		
		7439-89-6	Iron	ug/L		
		7439-92-1	Lead	ug/L		
		7439-95-4	Magnesium	ug/L		
		7439-96-5	Manganese	ug/L		
		7439-97-6	Mercury	ug/L		
		7440-02-0	Nickel	ug/L		
		7440-09-7	Potassium	ug/L		
		7782-49-2	Selenium	ug/L		
		7440-22-4	Silver	ug/L		
Inorganics	T	7440-23-5	Sodium	ug/L		27000
		7440-28-0	Thallium	ug/L		
		7440-62-2	Vanadium	ug/L		
		7440-66-6	Zinc	ug/L		
		16887-00-6	Chloride	ug/L		130,000
Specialty	T	14797-55-8	Nitrate as N	ug/L		230
		14797-65-0	Nitrite as N	ug/L		50 U
		HLA0043	Nitrogen, as Ammonia	ug/L		130 J
		14808-79-8	Sulfate	ug/L		24,000
		75-07-0	Acetaldehyde	ug/L		
TIC	T	50-00-0	Formaldehyde	ug/L		
		302-01-2	Hydrazine	ug/L		
		123-77-3	Kempore (Azodicarbonamide)	ug/L		
		60-34-4	Monomethylhydrazine (MMH)	ug/L		
		101-25-7	OPEX	ug/L		
		HLA0454	Phthalic Acid/Phthalic anhydride	ug/L		
		57-14-7	UDMH	ug/L		
		2050-75-1	2,3-Dichloronaphthalene	ug/L		
		506-12-7	Heptadecanoic Acid	ug/L		
		57-10-3	Hexadecanoic acid	ug/L		
		4237-44-9	Phenol, 2-(1-phenylethyl)-	ug/L		
		HLA0197	TIC Organic Acid(s)	ug/L		
		HLA0141	TIC PAH(s)	ug/L		
		HLA0058	TIC(s) Unspecified	ug/L		
		HLA0650	Unknown Hydrocarbons	ug/L		

Notes:
This table includes samples collected from January 1995 to November 8th 2017.
ug/L: micrograms per liter
FS: Field Sample
FD: Field Duplicate
FS&FD: Resolved result for the FS&FD, determined as follows:
if both results are ND, then the lower reporting limit is shown.
if both results are detected, then the average of the detected values is shown.
if one result is ND and the other is detected, the detected value is shown.
Qualifiers: U: not detected, J: estimated value, JN: tentatively identified
and value may not be consistent with amount present in the sample.
CAS: Chemical Abstracts Service Registry Number
VOC: Volatile Organic Compounds
SVOC: Semi-Volatile Organic Compounds
VPH: Volatile Petroleum Hydrocarbons
TIC: Tentatively Identiifed Compounds
Fraction: T: Total, D: Dissolved

Prepared by: JPK 2/27/2018
Checked by: LCG 2/27/2018

(1) Analytical method 8270C has been shown as a separate column from the other analytical methods performed for this sample. The results for SVOCs were resolved as the minimum of the reporting limit for non-detects.
(2) Results for multiple analytical methods used for this parameter are shown in separate rows. The final resolved result is shown in the row indicated with the (2), and was resolved in the same way as the FS&FD results (see above).

Attachment B

Comparison of Groundwater Intakes to Recommended Daily Intakes for Essential Nutrients

Attachment B: Essential Nutrients Evaluation

The United States Environmental Protection Agency (USEPA) has identified calcium, magnesium, sodium, and potassium as essential nutrients (USEPA, 1989). Per USEPA, essential nutrients do not need to be evaluated quantitatively in a risk assessment if they are present at low concentrations and are toxic only at very high doses (USEPA, 1989). However, before eliminating them as compounds of potential concern (COPC), it must be demonstrated that they are not present at concentrations at which adverse health effects could occur.

To assess whether calcium, magnesium, potassium, and sodium could be eliminated as COPCs, potential ingestion exposure to these essential nutrients was evaluated by calculating estimated daily intakes and comparing these values to recommended dietary intakes. The calculations were based on the exposure point concentration (EPC) identified for each of the compounds for a given exposure point for total and/or dissolved metals. The daily intake was calculated by multiplying the EPC by the adult ingestion rate (2.5 L/day) for a hypothetical residential exposure scenario (USEPA, 2017). This intake was then divided by the Recommended Daily Intake (RDI) (for adults and children 4 or more years of age) to yield the calculated daily intake as a percentage of the RDI (USFDA, 2016).

The results of these calculations are shown in Table B-1. For the private residential potable well exposure scenarios, the intake as percent of RDI ranges from 0.2 to 19 percent for calcium, magnesium, potassium, and sodium, indicating that these essential nutrients are present at concentrations that would not be anticipated to be toxic.

Based on the comparison of hypothetical potential daily intakes associated with groundwater to RDIs, calcium, magnesium, potassium, and sodium were not retained as COPCs for the private residential potable well exposure scenarios.

References

United States Environmental Protection Agency (USEPA), 2017. Regional Screening Levels (RSLs) - User's Guide, (November 2017). [<https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-november-2017>]

USEPA, 1989. *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)*"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C. December.

U.S. Food and Drug Administration (USFDA). 2016. Food Labeling: Revision of the Nutrition and Supplement Facts Labels, 21 CFR Part 101, Federal Register V. 81 No. 103, May 27, 2016.

Attachment B
Table B-1
Comparison of Groundwater Intakes to Recommended Daily Intakes for Essential Nutrients

Olin OU3
Wilmington, MA

		Recommended Daily Intakes (a) mg/day			
		Calcium	Magnesium	Potassium	Sodium
	Units	1,300	420	4,700	2,300
Current and Hypothetical Potable Exposure Scenario					
Private Residential Potable Wells Maximum EPC, total metals	mg/L	100	10	3.7	175
Daily Intake (b)	mg/day	250	25	9	438
Percent of Recommended Daily Intake (c)	-	19%	6%	0.2%	19%
Private Residential Potable Wells Maximum EPC, dissolved metals					
Daily Intake (b)	mg/day	180	35	8	83
Percent of Recommended Daily Intake (c)	-	14%	8%	0.2%	4%

Prepared by: JPK 2/12/2018
Checked by: KALS 2/13/2018

Notes:

EPC: Exposure Point Concentration

(a) Based on a 2,000 calorie intake; for adults and children 4 or more years of age.

U.S. Food and Drug Administration (FDA). 2016. Food Labeling: Revision of the Nutrition and Supplement Facts Labels, 21 CFR Part 101, Federal Register V. 81 No. 103, May 27, 2016.

(b) Daily Intake for hypothetical resident (mg/day) = Concentration (mg/L) x 2.5 L/day.

(c) Daily Intake (mg/day) / Recommended Daily Intake (mg/day).

Attachment C

ProUCL Outputs for UCL Calculations

Attachment C
UCL Calculations
Property 1 and Property 2 - Calcium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/9/2018 10:36:07 AM
From File ProUCL_DWW_2_8_18_b.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Calcium (m-24/l-54)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	21400	Mean	42390
Maximum	47000	Median	44000
SD	7528	Std. Error of Mean	2381
Coefficient of Variation	0.178	Skewness	-2.925

Normal GOF Test

Shapiro Wilk Test Statistic 0.552
5% Shapiro Wilk Critical Value 0.842
Lilliefors Test Statistic 0.385
5% Lilliefors Critical Value 0.262

Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

Lilliefors GOF Test

Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 46754

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 43953

95% Modified-t UCL (Johnson-1978) 46387

Gamma GOF Test

A-D Test Statistic 2.236
5% A-D Critical Value 0.725
K-S Test Statistic 0.409
5% K-S Critical Value 0.266

Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

Kolmogorov-Smirnov Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	24.36	k star (bias corrected MLE)	17.12
Theta hat (MLE)	1740	Theta star (bias corrected MLE)	2476
nu hat (MLE)	487.3	nu star (bias corrected)	342.4
MLE Mean (bias corrected)	42390	MLE Sd (bias corrected)	10245

Attachment C
UCL Calculations
Property 1 and Property 2 - Calcium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

	Approximate Chi Square Value (0.05)	300.5
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value 293.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	48297	95% Adjusted Gamma UCL (use when n<50)	49419
---	-------	--	-------

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.498
5% Shapiro Wilk Critical Value	0.842
Lilliefors Test Statistic	0.419
5% Lilliefors Critical Value	0.262

Shapiro Wilk Lognormal GOF Test

Data Not Lognormal at 5% Significance Level

Lilliefors Lognormal GOF Test

Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.971	Mean of logged Data	10.63
Maximum of Logged Data	10.76	SD of logged Data	0.235

Assuming Lognormal Distribution

95% H-UCL	49601	90% Chebyshev (MVUE) UCL	52114
95% Chebyshev (MVUE) UCL	56438	97.5% Chebyshev (MVUE) UCL	62440
99% Chebyshev (MVUE) UCL	74229		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	46306	95% Jackknife UCL	46754
95% Standard Bootstrap UCL	46013	95% Bootstrap-t UCL	45333
95% Hall's Bootstrap UCL	44791	95% Percentile Bootstrap UCL	45250
95% BCA Bootstrap UCL	44950		
90% Chebyshev(Mean, Sd) UCL	49532	95% Chebyshev(Mean, Sd) UCL	52767
97.5% Chebyshev(Mean, Sd) UCL	57257	99% Chebyshev(Mean, Sd) UCL	66078

Suggested UCL to Use

95% Student's-t UCL 46754	or 95% Modified-t UCL 46387
---------------------------	-----------------------------

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Attachment C
UCL Calculations
Property 1 and Property 2 - Calcium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Calcium (m-24/l-94)

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	19000	Mean	37685
Maximum	67000	Median	36000
SD	14397	Std. Error of Mean	3993
Coefficient of Variation	0.382	Skewness	0.57

Normal GOF Test

Shapiro Wilk Test Statistic	0.954
5% Shapiro Wilk Critical Value	0.866
Lilliefors Test Statistic	0.134
5% Lilliefors Critical Value	0.234

Shapiro Wilk GOF Test

Data appear Normal at 5% Significance Level

Lilliefors GOF Test

Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 44801

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 44927

95% Modified-t UCL (Johnson-1978) 44907

Gamma GOF Test

A-D Test Statistic	0.187
5% A-D Critical Value	0.735
K-S Test Statistic	0.111
5% K-S Critical Value	0.237

Anderson-Darling Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Kolmogorov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.429	k star (bias corrected MLE)	5.766
Theta hat (MLE)	5073	Theta star (bias corrected MLE)	6536
nu hat (MLE)	193.2	nu star (bias corrected)	149.9
MLE Mean (bias corrected)	37685	MLE Sd (bias corrected)	15694
		Approximate Chi Square Value (0.05)	122.6
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	119.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$) 46075

95% Adjusted Gamma UCL (use when $n < 50$) 47435

Lognormal GOF Test

Attachment C
UCL Calculations
Property 1 and Property 2 - Calcium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Shapiro Wilk Test Statistic	0.966	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.11	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.234	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	9.852	Mean of logged Data	10.47
Maximum of Logged Data	11.11	SD of logged Data	0.391

Assuming Lognormal Distribution

95% H-UCL	47551	90% Chebyshev (MVUE) UCL	50211
95% Chebyshev (MVUE) UCL	55862	97.5% Chebyshev (MVUE) UCL	63705
99% Chebyshev (MVUE) UCL	79112		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	44253	95% Jackknife UCL	44801
95% Standard Bootstrap UCL	43852	95% Bootstrap-t UCL	45739
95% Hall's Bootstrap UCL	45895	95% Percentile Bootstrap UCL	44300
95% BCA Bootstrap UCL	44069		
90% Chebyshev(Mean, Sd) UCL	49664	95% Chebyshev(Mean, Sd) UCL	55090
97.5% Chebyshev(Mean, Sd) UCL	62621	99% Chebyshev(Mean, Sd) UCL	77415

Suggested UCL to Use

95% Student's-t UCL 44801

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Chloride
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/9/2018 10:41:04 AM
From File ProUCL_DWW_2_8_18_c.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Chloride (m-24/I-54)

General Statistics

Total Number of Observations 33	Number of Distinct Observations 19
	Number of Missing Observations 0
Minimum 33200	Mean 76264
Maximum 89000	Median 80000
SD 13110	Std. Error of Mean 2282
Coefficient of Variation 0.172	Skewness -2.315

Normal GOF Test

Shapiro Wilk Test Statistic 0.709	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value 0.931	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic 0.267	Lilliefors GOF Test
5% Lilliefors Critical Value 0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 80129

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 79035

95% Modified-t UCL (Johnson-1978) 79976

Gamma GOF Test

A-D Test Statistic 4.235	Anderson-Darling Gamma GOF Test
5% A-D Critical Value 0.746	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic 0.311	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value 0.153	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE) 24.43	k star (bias corrected MLE) 22.23
Theta hat (MLE) 3122	Theta star (bias corrected MLE) 3431
nu hat (MLE) 1612	nu star (bias corrected) 1467
MLE Mean (bias corrected) 76264	MLE Sd (bias corrected) 16176

Attachment C
UCL Calculations
Property 1 and Property 2 - Chloride
Human Health Risk Assessment

Olin OU3
Wilmington, MA

	Approximate Chi Square Value (0.05)	1379
Adjusted Level of Significance	0.0419	Adjusted Chi Square Value 1375

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$)	81127
95% Adjusted Gamma UCL (use when $n < 50$)	81385

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.607	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.931	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.332	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.152	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	10.41	Mean of logged Data 11.22
Maximum of Logged Data	11.4	SD of logged Data 0.227

Assuming Lognormal Distribution

95% H-UCL	82248
95% Chebyshev (MVUE) UCL	89895
99% Chebyshev (MVUE) UCL	106959
90% Chebyshev (MVUE) UCL	85748
97.5% Chebyshev (MVUE) UCL	95651

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	80017
95% Standard Bootstrap UCL	80019
95% Hall's Bootstrap UCL	79217
95% BCA Bootstrap UCL	79242
90% Chebyshev(Mean, Sd) UCL	83110
97.5% Chebyshev(Mean, Sd) UCL	90516
95% Jackknife UCL	80129
95% Bootstrap-t UCL	79297
95% Percentile Bootstrap UCL	79764
95% Chebyshev(Mean, Sd) UCL	86211
99% Chebyshev(Mean, Sd) UCL	98971

Suggested UCL to Use

95% Student's-t UCL 80129	or 95% Modified-t UCL 79976
---------------------------	-----------------------------

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Attachment C
UCL Calculations
Property 1 and Property 2 - Chloride
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Chloride (m-24/I-94)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	31
		Number of Missing Observations	0
Minimum	2500	Mean	100516
Maximum	320000	Median	92000
SD	68952	Std. Error of Mean	11336
Coefficient of Variation	0.686	Skewness	1.353

Normal GOF Test

Shapiro Wilk Test Statistic	0.896	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.146	Lilliefors GOF Test
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL	95% UCLs (Adjusted for Skewness)
95% Student's-t UCL 119654	95% Adjusted-CLT UCL (Chen-1995) 121855
	95% Modified-t UCL (Johnson-1978) 120074

Gamma GOF Test

A-D Test Statistic	0.377	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.76	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0911	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.147	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.955	k star (bias corrected MLE)	1.814
Theta hat (MLE)	51427	Theta star (bias corrected MLE)	55409
nu hat (MLE)	144.6	nu star (bias corrected)	134.2
MLE Mean (bias corrected)	100516	MLE Sd (bias corrected)	74629
		Approximate Chi Square Value (0.05)	108.5
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	107.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$) 124394	95% Adjusted Gamma UCL (use when $n < 50$) 125556
--	--

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.887	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.936	Data Not Lognormal at 5% Significance Level

Attachment C
UCL Calculations
Property 1 and Property 2 - Chloride
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Lilliefors Test Statistic	0.142	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.144	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.824	Mean of logged Data	11.24
Maximum of Logged Data	12.68	SD of logged Data	0.889

Assuming Lognormal Distribution

95% H-UCL 158207	90% Chebyshev (MVUE) UCL 166808
95% Chebyshev (MVUE) UCL 191877	97.5% Chebyshev (MVUE) UCL 226672
99% Chebyshev (MVUE) UCL 295020	

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL 119162	95% Jackknife UCL 119654
95% Standard Bootstrap UCL 119104	95% Bootstrap-t UCL 122788
95% Hall's Bootstrap UCL 126753	95% Percentile Bootstrap UCL 120081
95% BCA Bootstrap UCL 121897	
90% Chebyshev(Mean, Sd) UCL 134523	95% Chebyshev(Mean, Sd) UCL 149927
97.5% Chebyshev(Mean, Sd) UCL 171308	99% Chebyshev(Mean, Sd) UCL 213305

Suggested UCL to Use

95% Adjusted Gamma UCL 125556

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Sodium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/9/2018 11:05:18 AM
From File ProUCL_DWW_2_8_18_h.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Sodium (m-24/l-54)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	23000	Mean	28038
Maximum	31000	Median	28000
SD	2075	Std. Error of Mean	366.8
Coefficient of Variation	0.074	Skewness	-0.778

Normal GOF Test

Shapiro Wilk Test Statistic 0.928
5% Shapiro Wilk Critical Value 0.93
Lilliefors Test Statistic 0.147
5% Lilliefors Critical Value 0.154

Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

Lilliefors GOF Test

Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 28659

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 28587
95% Modified-t UCL (Johnson-1978) 28651

Gamma GOF Test

A-D Test Statistic 0.792
5% A-D Critical Value 0.745
K-S Test Statistic 0.153
5% K-S Critical Value 0.155

Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

Kolmogorov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Aprpr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	180.5	k star (bias corrected MLE)	163.6
Theta hat (MLE)	155.3	Theta star (bias corrected MLE)	171.4
nu hat (MLE)	11552	nu star (bias corrected)	10470
MLE Mean (bias corrected)	28038	MLE Sd (bias corrected)	2192

Attachment C
UCL Calculations
Property 1 and Property 2 - Sodium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

	Approximate Chi Square Value (0.05) 10233	
Adjusted Level of Significance 0.0416	Adjusted Chi Square Value 10221	

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50) 28687	95% Adjusted Gamma UCL (use when n<50) 28722
--	--

Lognormal GOF Test

Shapiro Wilk Test Statistic 0.911		Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value 0.93		Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic 0.152		Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value 0.154		Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data 10.04		Mean of logged Data 10.24
Maximum of Logged Data 10.34		SD of logged Data 0.0765

Assuming Lognormal Distribution

95% H-UCL N/A	90% Chebyshev (MVUE) UCL 29179
95% Chebyshev (MVUE) UCL 29695	97.5% Chebyshev (MVUE) UCL 30411
99% Chebyshev (MVUE) UCL 31818	

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL 28641	95% Jackknife UCL 28659
95% Standard Bootstrap UCL 28644	95% Bootstrap-t UCL 28610
95% Hall's Bootstrap UCL 28644	95% Percentile Bootstrap UCL 28609
95% BCA Bootstrap UCL 28578	
90% Chebyshev(Mean, Sd) UCL 29138	95% Chebyshev(Mean, Sd) UCL 29637
97.5% Chebyshev(Mean, Sd) UCL 30328	99% Chebyshev(Mean, Sd) UCL 31688

Suggested UCL to Use

95% Student's-t UCL 28659

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Sodium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Sodium (m-24/l-94)

General Statistics

Total Number of Observations	35	Number of Distinct Observations	26
		Number of Missing Observations	0
Minimum	18000	Mean	44637
Maximum	150000	Median	36600
SD	27783	Std. Error of Mean	4696
Coefficient of Variation	0.622	Skewness	2.259

Normal GOF Test

Shapiro Wilk Test Statistic	0.772
5% Shapiro Wilk Critical Value	0.934
Lilliefors Test Statistic	0.169
5% Lilliefors Critical Value	0.148

Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

Lilliefors GOF Test

Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 52578

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 54278

95% Modified-t UCL (Johnson-1978) 52877

Gamma GOF Test

A-D Test Statistic	0.806
5% A-D Critical Value	0.753
K-S Test Statistic	0.115
5% K-S Critical Value	0.149

Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

Kolmogorov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.817	k star (bias corrected MLE)	3.509
Theta hat (MLE)	11695	Theta star (bias corrected MLE)	12721
nu hat (MLE)	267.2	nu star (bias corrected)	245.6
MLE Mean (bias corrected)	44637	MLE Sd (bias corrected)	23830
		Approximate Chi Square Value (0.05)	210.3
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	208.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$) 52125

95% Adjusted Gamma UCL (use when $n < 50$) 52511

Attachment C
UCL Calculations
Property 1 and Property 2 - Sodium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.934	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0862	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.148	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.798	Mean of logged Data	10.57
Maximum of Logged Data	11.92	SD of logged Data	0.502

Assuming Lognormal Distribution

95% H-UCL	52219	90% Chebyshev (MVUE) UCL	55716
95% Chebyshev (MVUE) UCL	61027	97.5% Chebyshev (MVUE) UCL	68398
99% Chebyshev (MVUE) UCL	82878		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	52362	95% Jackknife UCL	52578
95% Standard Bootstrap UCL	52223	95% Bootstrap-t UCL	55543
95% Hall's Bootstrap UCL	60998	95% Percentile Bootstrap UCL	53220
95% BCA Bootstrap UCL	54894		
90% Chebyshev(Mean, Sd) UCL	58725	95% Chebyshev(Mean, Sd) UCL	65107
97.5% Chebyshev(Mean, Sd) UCL	73964	99% Chebyshev(Mean, Sd) UCL	91363

Suggested UCL to Use

95% Adjusted Gamma UCL 52511

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Sodium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Sodium (m-27/l-14c)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	22000	Mean	29322
Maximum	41000	Median	28500
SD	5910	Std. Error of Mean	1393
Coefficient of Variation	0.202	Skewness	0.605

Normal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.188	Lilliefors GOF Test
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 31745

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 31826
95% Modified-t UCL (Johnson-1978) 31779

Gamma GOF Test

A-D Test Statistic	0.59	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.164	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.203	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	27.28	k star (bias corrected MLE)	22.77
Theta hat (MLE)	1075	Theta star (bias corrected MLE)	1288
nu hat (MLE)	982.2	nu star (bias corrected)	819.8
MLE Mean (bias corrected)	29322	MLE Sd (bias corrected)	6145
		Approximate Chi Square Value (0.05)	754.3
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	748.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50) 31866

95% Adjusted Gamma UCL (use when n<50) 32123

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level

Attachment C
UCL Calculations
Property 1 and Property 2 - Sodium
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Lilliefors Test Statistic	0.153	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.999	Mean of logged Data	10.27
Maximum of Logged Data	10.62	SD of logged Data	0.196

Assuming Lognormal Distribution

95% H-UCL	31938	90% Chebyshev (MVUE) UCL	33392
95% Chebyshev (MVUE) UCL	35240	97.5% Chebyshev (MVUE) UCL	37805
99% Chebyshev (MVUE) UCL	42844		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	31613	95% Jackknife UCL	31745
95% Standard Bootstrap UCL	31558	95% Bootstrap-t UCL	32068
95% Hall's Bootstrap UCL	31693	95% Percentile Bootstrap UCL	31644
95% BCA Bootstrap UCL	31878		
90% Chebyshev(Mean, Sd) UCL	33501	95% Chebyshev(Mean, Sd) UCL	35394
97.5% Chebyshev(Mean, Sd) UCL	38021	99% Chebyshev(Mean, Sd) UCL	43182

Suggested UCL to Use

95% Student's-t UCL 31745

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Nitrogen, as Ammonia
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/14/2018 5:24:16 PM
From File ProUCL_DWW_2_12_18.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Nitrogen, as Ammonia (m-24/l-94)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	15
		Number of Missing Observations	5
Number of Detects	9	Number of Non-Detects	28
Number of Distinct Detects	7	Number of Distinct Non-Detects	8
Minimum Detect	12	Minimum Non-Detect	20
Maximum Detect	660	Maximum Non-Detect	500
Variance Detects	37415	Percent Non-Detects	75.68%
Mean Detects	162.2	SD Detects	193.4
Median Detects	130	CV Detects	1.192
Skewness Detects	2.589	Kurtosis Detects	7.36
Mean of Logged Detects	4.551	SD of Logged Detects	1.194

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.624	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.414	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	57.88	KM Standard Error of Mean	20.11
KM SD	111.1	95% KM (BCA) UCL	96.34
95% KM (t) UCL	91.83	95% KM (Percentile Bootstrap) UCL	94.14
95% KM (z) UCL	90.96	95% KM Bootstrap t UCL	117.5
90% KM Chebyshev UCL	118.2	95% KM Chebyshev UCL	145.5
97.5% KM Chebyshev UCL	183.5	99% KM Chebyshev UCL	258

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.795	Anderson-Darling GOF Test
5% A-D Critical Value	0.742	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.291	Kolmogorov-Smirnov GOF

Attachment C
UCL Calculations
Property 1 and Property 2 - Nitrogen, as Ammonia
Human Health Risk Assessment

Olin OU3
Wilmington, MA

5% K-S Critical Value 0.287 Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.065	k star (bias corrected MLE)	0.784
Theta hat (MLE)	152.4	Theta star (bias corrected MLE)	207
nu hat (MLE)	19.16	nu star (bias corrected)	14.11
Mean (detects)	162.2		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	46.39
Maximum	660	Median	0.01
SD	115	CV	2.478
k hat (MLE)	0.155	k star (bias corrected MLE)	0.161
Theta hat (MLE)	298.3	Theta star (bias corrected MLE)	288.3
nu hat (MLE)	11.51	nu star (bias corrected)	11.91
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (11.91, α)	5.165	Adjusted Chi Square Value (11.91, β)	4.973
95% Gamma Approximate UCL (use when $n \geq 50$)	106.9	95% Gamma Adjusted UCL (use when $n < 50$)	111.1

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	57.88	SD (KM)	111.1
Variance (KM)	12344	SE of Mean (KM)	20.11
k hat (KM)	0.271	k star (KM)	0.267
nu hat (KM)	20.08	nu star (KM)	19.79
theta hat (KM)	213.3	theta star (KM)	216.5
80% gamma percentile (KM)	85.97	90% gamma percentile (KM)	172.8
95% gamma percentile (KM)	274.5	99% gamma percentile (KM)	542.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (19.79, α)	10.69	Adjusted Chi Square Value (19.79, β)	10.4
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	107.1	95% Gamma Adjusted KM-UCL (use when $n < 50$)	110.1

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.849	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.328	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Level	

Attachment C
UCL Calculations
Property 1 and Property 2 - Nitrogen, as Ammonia
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	58.11	Mean in Log Scale	3.326
SD in Original Scale	110.2	SD in Log Scale	1.136
95% t UCL (assumes normality of ROS data)	88.71	95% Percentile Bootstrap UCL	89.68
95% BCA Bootstrap UCL	107.9	95% Bootstrap t UCL	128.9
95% H-UCL (Log ROS)	85.9		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.276	KM Geo Mean	26.46
KM SD (logged)	1.062	95% Critical H Value (KM-Log)	2.46
KM Standard Error of Mean (logged)	0.236	95% H-UCL (KM -Log)	71.85
KM SD (logged)	1.062	95% Critical H Value (KM-Log)	2.46
KM Standard Error of Mean (logged)	0.236		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	96.89	Mean in Log Scale	4.123
SD in Original Scale	110.9	SD in Log Scale	1.017
95% t UCL (Assumes normality)	127.7	95% H-Stat UCL	155.9

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 71.85

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2- NDMA
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/9/2018 11:00:55 AM
From File ProUCL_DWW_2_8_18_g.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

N-Nitrosodimethylamine (m-24/l-54)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	15
Number of Detects	29	Number of Non-Detects	3
Number of Distinct Detects	14	Number of Distinct Non-Detects	1
Minimum Detect	0.0091	Minimum Non-Detect	0.0019
Maximum Detect	0.024	Maximum Non-Detect	0.0019
Variance Detects	1.3718E-5	Percent Non-Detects	9.375%
Mean Detects	0.0141	SD Detects	0.0037
Median Detects	0.013	CV Detects	0.264
Skewness Detects	1.06	Kurtosis Detects	0.835
Mean of Logged Detects	-4.296	SD of Logged Detects	0.247

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.914	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.926	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	Lilliefors GOF Test
5% Lilliefors Critical Value	0.161	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0129	KM Standard Error of Mean	8.9137E-4
KM SD	0.00495	95% KM (BCA) UCL	0.0143
95% KM (t) UCL	0.0144	95% KM (Percentile Bootstrap) UCL	0.0143
95% KM (z) UCL	0.0144	95% KM Bootstrap t UCL	0.0144
90% KM Chebyshev UCL	0.0156	95% KM Chebyshev UCL	0.0168
97.5% KM Chebyshev UCL	0.0185	99% KM Chebyshev UCL	0.0218

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.485	Anderson-Darling GOF Test
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.162	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Attachment C
UCL Calculations
Property 1 and Property 2- NDMA
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Gamma Statistics on Detected Data Only

k hat (MLE)	16.48	k star (bias corrected MLE)	14.8
Theta hat (MLE)	8.5266E-4	Theta star (bias corrected MLE)	9.4956E-4
nu hat (MLE)	955.8	nu star (bias corrected)	858.3
Mean (detects)	0.0141		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0091	Mean	0.0137
Maximum	0.024	Median	0.013
SD	0.00372	CV	0.272
k hat (MLE)	15.66	k star (bias corrected MLE)	14.22
Theta hat (MLE)	8.7281E-4	Theta star (bias corrected MLE)	9.6169E-4
nu hat (MLE)	1003	nu star (bias corrected)	909.9
Adjusted Level of Significance (β)	0.0416		
Approximate Chi Square Value (909.86, α)	840.8	Adjusted Chi Square Value (909.86, β)	837.3
95% Gamma Approximate UCL (use when $n \geq 50$)	0.0148	95% Gamma Adjusted UCL (use when $n < 50$)	0.0149

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0129	SD (KM)	0.00495
Variance (KM)	2.4549E-5	SE of Mean (KM)	8.9137E-4
k hat (KM)	6.792	k star (KM)	6.176
nu hat (KM)	434.7	nu star (KM)	395.3
theta hat (KM)	0.0019	theta star (KM)	0.00209
80% gamma percentile (KM)	0.017	90% gamma percentile (KM)	0.0199
95% gamma percentile (KM)	0.0225	99% gamma percentile (KM)	0.028

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (395.27, α)	350.2	Adjusted Chi Square Value (395.27, β)	347.9
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	0.0146	95% Gamma Adjusted KM-UCL (use when $n < 50$)	0.0147

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.963	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.926	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.127	Lilliefors GOF Test
5% Lilliefors Critical Value	0.161	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Attachment C
UCL Calculations
Property 1 and Property 2- NDMA
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0135	Mean in Log Scale	-4.35
SD in Original Scale	0.004	SD in Log Scale	0.292
95% t UCL (assumes normality of ROS data)	0.0147	95% Percentile Bootstrap UCL	0.0146
95% BCA Bootstrap UCL	0.0147	95% Bootstrap t UCL	0.0148
95% H-UCL (Log ROS)	0.0148		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.48	KM Geo Mean	0.0113
KM SD (logged)	0.619	95% Critical H Value (KM-Log)	2.031
KM Standard Error of Mean (logged)	0.111	95% H-UCL (KM -Log)	0.0172
KM SD (logged)	0.619	95% Critical H Value (KM-Log)	2.031
KM Standard Error of Mean (logged)	0.111		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0128	Mean in Log Scale	-4.545
SD in Original Scale	0.00524	SD in Log Scale	0.823
95% t UCL (Assumes normality)	0.0144	95% H-Stat UCL	0.0207

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.0147	95% GROS Adjusted Gamma UCL	0.0149
---------------------------	--------	-----------------------------	--------

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2- NDMA
Human Health Risk Assessment

Olin OU3
Wilmington, MA

N-Nitrosodimethylamine (m-24/l-94)

General Statistics

Total Number of Observations	36	Number of Distinct Observations	26
Number of Detects	23	Number of Non-Detects	13
Number of Distinct Detects	22	Number of Distinct Non-Detects	4
Minimum Detect	5.1000E-4	Minimum Non-Detect	0.0019
Maximum Detect	0.056	Maximum Non-Detect	0.019
Variance Detects	1.7487E-4	Percent Non-Detects	36.11%
Mean Detects	0.0104	SD Detects	0.0132
Median Detects	0.0055	CV Detects	1.267
Skewness Detects	2.346	Kurtosis Detects	5.926
Mean of Logged Detects	-5.205	SD of Logged Detects	1.204

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.703	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.258	Lilliefors GOF Test
5% Lilliefors Critical Value	0.18	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00715	KM Standard Error of Mean	0.00192
KM SD	0.0113	95% KM (BCA) UCL	0.0106
95% KM (t) UCL	0.0104	95% KM (Percentile Bootstrap) UCL	0.0106
95% KM (z) UCL	0.0103	95% KM Bootstrap t UCL	0.0124
90% KM Chebyshev UCL	0.0129	95% KM Chebyshev UCL	0.0155
97.5% KM Chebyshev UCL	0.0192	99% KM Chebyshev UCL	0.0263

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.423	Anderson-Darling GOF Test
5% A-D Critical Value	0.774	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.187	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.908	k star (bias corrected MLE)	0.819
Theta hat (MLE)	0.0115	Theta star (bias corrected MLE)	0.0127
nu hat (MLE)	41.79	nu star (bias corrected)	37.67
Mean (detects)	0.0104		

Attachment C
UCL Calculations
Property 1 and Property 2 - NDMA
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.1000E-4	Mean	0.0103
Maximum	0.056	Median	0.01
SD	0.0105	CV	1.02
k hat (MLE)	1.36	k star (bias corrected MLE)	1.265
Theta hat (MLE)	0.00756	Theta star (bias corrected MLE)	0.00813
nu hat (MLE)	97.89	nu star (bias corrected)	91.06
Adjusted Level of Significance (β)	0.0428		
Approximate Chi Square Value (91.06, α)	70.06	Adjusted Chi Square Value (91.06, β)	69.22
95% Gamma Approximate UCL (use when $n \geq 50$)	0.0134	95% Gamma Adjusted UCL (use when $n < 50$)	0.0135

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00715	SD (KM)	0.0113
Variance (KM)	1.2675E-4	SE of Mean (KM)	0.00192
k hat (KM)	0.404	k star (KM)	0.389
nu hat (KM)	29.07	nu star (KM)	27.98
theta hat (KM)	0.0177	theta star (KM)	0.0184
80% gamma percentile (KM)	0.0115	90% gamma percentile (KM)	0.0203
95% gamma percentile (KM)	0.03	99% gamma percentile (KM)	0.0545

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (27.98, α)	16.91	Adjusted Chi Square Value (27.98, β)	16.52
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	0.0118	95% Gamma Adjusted KM-UCL (use when $n < 50$)	0.0121

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.987	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0921	Lilliefors GOF Test
5% Lilliefors Critical Value	0.18	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00713	Mean in Log Scale	-5.794
SD in Original Scale	0.0114	SD in Log Scale	1.298
95% t UCL (assumes normality of ROS data)	0.0103	95% Percentile Bootstrap UCL	0.0106
95% BCA Bootstrap UCL	0.0114	95% Bootstrap t UCL	0.013
95% H-UCL (Log ROS)	0.0129		

Attachment C
UCL Calculations
Property 1 and Property 2- NDMA
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.788	KM Geo Mean	0.00306
KM SD (logged)	1.264	95% Critical H Value (KM-Log)	2.7
KM Standard Error of Mean (logged)	0.232	95% H-UCL (KM -Log)	0.0121
KM SD (logged)	1.264	95% Critical H Value (KM-Log)	2.7
KM Standard Error of Mean (logged)	0.232		

DL/2 Statistics

DL/2 Normal

Mean in Original Scale	0.00725
SD in Original Scale	0.0114
95% t UCL (Assumes normality)	0.0105

DL/2 Log-Transformed

Mean in Log Scale	-5.768
SD in Log Scale	1.274
95% H-Stat UCL	0.0126

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

justed KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$) 0.0121

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Nitrate
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/9/2018 10:58:48 AM
From File ProUCL_DWW_2_8_18_e.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Nitrate as N (m-24/l-94)

General Statistics

Total Number of Observations	35	Number of Distinct Observations	26
		Number of Missing Observations	0
Minimum	230	Mean	1608
Maximum	4800	Median	1500
SD	1092	Std. Error of Mean	184.6
Coefficient of Variation	0.679	Skewness	0.895

Normal GOF Test

Shapiro Wilk Test Statistic 0.93
5% Shapiro Wilk Critical Value 0.934
Lilliefors Test Statistic 0.104
5% Lilliefors Critical Value 0.148

Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

Lilliefors GOF Test

Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 1920

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 1941
95% Modified-t UCL (Johnson-1978) 1925

Gamma GOF Test

A-D Test Statistic 0.418
5% A-D Critical Value 0.76
K-S Test Statistic 0.112
5% K-S Critical Value 0.151

Anderson-Darling Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Kolmogorov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.944	k star (bias corrected MLE)	1.797
Theta hat (MLE)	826.9	Theta star (bias corrected MLE)	894.8
nu hat (MLE)	136.1	nu star (bias corrected)	125.8
MLE Mean (bias corrected)	1608	MLE Sd (bias corrected)	1199

Attachment C
UCL Calculations
Property 1 and Property 2 - Nitrate
Human Health Risk Assessment

Olin OU3
Wilmington, MA

		Approximate Chi Square Value (0.05)	100.9
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	99.81

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2005	95% Adjusted Gamma UCL (use when n<50)	2026
---	------	--	------

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.931
5% Shapiro Wilk Critical Value	0.934
Lilliefors Test Statistic	0.16
5% Lilliefors Critical Value	0.148

Shapiro Wilk Lognormal GOF Test

Data Not Lognormal at 5% Significance Level

Lilliefors Lognormal GOF Test

Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.438	Mean of logged Data	7.104
Maximum of Logged Data	8.476	SD of logged Data	0.831

Assuming Lognormal Distribution

95% H-UCL	2373	90% Chebyshev (MVUE) UCL	2495
95% Chebyshev (MVUE) UCL	2857	97.5% Chebyshev (MVUE) UCL	3359
99% Chebyshev (MVUE) UCL	4345		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1911	95% Jackknife UCL	1920
95% Standard Bootstrap UCL	1915	95% Bootstrap-t UCL	1953
95% Hall's Bootstrap UCL	1952	95% Percentile Bootstrap UCL	1907
95% BCA Bootstrap UCL	1940		
90% Chebyshev(Mean, Sd) UCL	2162	95% Chebyshev(Mean, Sd) UCL	2412
97.5% Chebyshev(Mean, Sd) UCL	2761	99% Chebyshev(Mean, Sd) UCL	3444

Suggested UCL to Use

95% Student's-t UCL 1920

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment C
UCL Calculations
Property 1 and Property 2 - Sulfate
Human Health Risk Assessment

Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.12/9/2018 11:10:24 AM
From File ProUCL_DWW_2_8_18_i.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Sulfate (m-24/l-54)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	13000	Mean	25485
Maximum	35000	Median	26000
SD	3483	Std. Error of Mean	606.3
Coefficient of Variation	0.137	Skewness	-0.799

Normal GOF Test

Shapiro Wilk Test Statistic 0.889
5% Shapiro Wilk Critical Value 0.931
Lilliefors Test Statistic 0.183
5% Lilliefors Critical Value 0.152

Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

Lilliefors GOF Test

Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL

95% Student's-t UCL 26512

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 26392

95% Modified-t UCL (Johnson-1978) 26498

Gamma GOF Test

A-D Test Statistic 1.538
5% A-D Critical Value 0.745
K-S Test Statistic 0.207
5% K-S Critical Value 0.153

Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

Kolmogorov-Smirnov Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	47.54	k star (bias corrected MLE)	43.24
Theta hat (MLE)	536	Theta star (bias corrected MLE)	589.4
nu hat (MLE)	3138	nu star (bias corrected)	2854
MLE Mean (bias corrected)	25485	MLE Sd (bias corrected)	3876
		Approximate Chi Square Value (0.05)	2731

Attachment C
UCL Calculations
Property 1 and Property 2 - Sulfate
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Adjusted Level of Significance 0.0419

Adjusted Chi Square Value 2725

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$) 26634

95% Adjusted Gamma UCL (use when $n < 50$) 26694

Lognormal GOF Test

Shapiro Wilk Test Statistic 0.796

Shapiro Wilk Lognormal GOF Test

5% Shapiro Wilk Critical Value 0.931

Data Not Lognormal at 5% Significance Level

Lilliefors Test Statistic 0.223

Lilliefors Lognormal GOF Test

5% Lilliefors Critical Value 0.152

Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data 9.473

Mean of logged Data 10.14

Maximum of Logged Data 10.46

SD of logged Data 0.155

Assuming Lognormal Distribution

95% H-UCL 26757

90% Chebyshev (MVUE) UCL 27587

95% Chebyshev (MVUE) UCL 28526

97.5% Chebyshev (MVUE) UCL 29830

99% Chebyshev (MVUE) UCL 32392

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL 26482

95% Jackknife UCL 26512

95% Standard Bootstrap UCL 26458

95% Bootstrap-t UCL 26412

95% Hall's Bootstrap UCL 26467

95% Percentile Bootstrap UCL 26455

95% BCA Bootstrap UCL 26394

90% Chebyshev(Mean, Sd) UCL 27304

95% Chebyshev(Mean, Sd) UCL 28128

97.5% Chebyshev(Mean, Sd) UCL 29271

99% Chebyshev(Mean, Sd) UCL 31518

Suggested UCL to Use

95% Student's-t UCL 26512

or 95% Modified-t UCL 26498

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Attachment C
UCL Calculations
Property 1 and Property 2 - Sulfate
Human Health Risk Assessment

Olin OU3
Wilmington, MA

Sulfate (m-24/l-94)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	13000	Mean	20046
Maximum	29000	Median	20000
SD	3951	Std. Error of Mean	649.6
Coefficient of Variation	0.197	Skewness	0.326

Normal GOF Test

Shapiro Wilk Test Statistic	0.956	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.936	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.157	Lilliefors GOF Test
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL	95% UCLs (Adjusted for Skewness)
95% Student's-t UCL 21143	95% Adjusted-CLT UCL (Chen-1995) 21152
	95% Modified-t UCL (Johnson-1978) 21148

Gamma GOF Test

A-D Test Statistic	0.491	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.143	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.145	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	26.43	k star (bias corrected MLE)	24.3
Theta hat (MLE)	758.5	Theta star (bias corrected MLE)	824.8
nu hat (MLE)	1956	nu star (bias corrected)	1798
MLE Mean (bias corrected)	20046	MLE Sd (bias corrected)	4066
		Approximate Chi Square Value (0.05)	1701
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	1697

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21195	95% Adjusted Gamma UCL (use when n<50)	21246
---	-------	--	-------

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.132	Lilliefors Lognormal GOF Test

Attachment C
UCL Calculations
Property 1 and Property 2 - Sulfate
Human Health Risk Assessment

Olin OU3
Wilmington, MA

5% Lilliefors Critical Value 0.144 Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.473	Mean of logged Data	9.887
Maximum of Logged Data	10.28	SD of logged Data	0.199

Assuming Lognormal Distribution

95% H-UCL	21248	90% Chebyshev (MVUE) UCL	22031
95% Chebyshev (MVUE) UCL	22928	97.5% Chebyshev (MVUE) UCL	24174
99% Chebyshev (MVUE) UCL	26621		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21114	95% Jackknife UCL	21143
95% Standard Bootstrap UCL	21066	95% Bootstrap-t UCL	21150
95% Hall's Bootstrap UCL	21169	95% Percentile Bootstrap UCL	21054
95% BCA Bootstrap UCL	21100		
90% Chebyshev(Mean, Sd) UCL	21995	95% Chebyshev(Mean, Sd) UCL	22877
97.5% Chebyshev(Mean, Sd) UCL	24102	99% Chebyshev(Mean, Sd) UCL	26509

Suggested UCL to Use

95% Student's-t UCL 21143

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Attachment D

Air concentration of VOCs while showering - Property 1 and Property 2

TABLE D-1
AIR CONCENTRATION OF VOCS WHILE SHOWERING - Property 1 and Property 2
RECEPTOR: ADULT RESIDENT - CURRENT LAND USE
Human Health Risk Assessment
Olin OU3
Wilmington, MA

EMPIRICAL CONSTANTS					EQUATIONS
PARAMETER	SYMBOL	VALUE	UNITS	SOURCE	
LIQUID-FILM MASS TRANSFER FOR CO2	Kl (CO2)	20	cm/hr	Calculated	$[OHM]_{ra} = (S/R) \times (e^{(RDS)} - 1) \times e^{(-Rt)}$
GAS-FILM MASS TRANSFER FOR WATER	Kg (H2O)	3000	cm/hr	Calculated	
MOLAR GAS CONSTANT X TEMPERATURE	RT	0.024	atm-m ³ /mole		$k_l = Kl(CO_2) \times (44/MW)^{1/2}$
REFERENCE TEMPERATURE	Tl	293	K		
TEMPERATURE OF SHOWER WATER	Ts	318	K	Assumption	$k_g = Kg(CO_2) \times (18/MW)^{1/2}$
VISCOSITY OF WATER AT SHOWER TEMPERATURE	us	0.596	Cp	Calculated	
VISCOSITY OF WATER AT REFERENCE TEMPERATURE	ul	1.002	Cp	Calculated	$K_L = (1/k_l + RT/Hk_g)^{-1}$
SHOWER DROPLET FREE-FALL TIME	ts	2.0	sec	Assumption	
DROPLET DIAMETER	d	1	mm	Foster & Chrostowski, 1987	$K_{at} = K_L \times ((T_l \times u_{s_l}) / (T_s \times u_{s_l}))^{-1/2}$
FLOW RATE IN SHOWER	FR	10	l/min	Assumption [a]	
VOLUME OF SHOWER AREA	SV	6	m ³	Assumption [b]	$C_{wd} = C_w \times (1 - e^{-k_d \times t_l}) / (60d) \times 1000$
AIR EXCHANGE RATE	R	0.00833	min-1	Foster & Chrostowski, 1987	
TIME IN SHOWER	Ds	21.3	min	Assumption	$S = C_{wd} \times FR / SV$
TIME AT WHICH CONCENTRATION IS BEING CALCULATED	t	42.6	min	USEPA, 2014	
MOLECULAR WEIGHT	MW	chemical-specific	g/mol		
HENRY'S LAW CONSTANT	H	chemical-specific	atm-m ³ /mole		
CHEMICAL-SPECIFIC MASS-TRANSFER COEFFICIENT	kl	chemical-specific	cm/hr	Calculated	
CHEMICAL-SPECIFIC GAS MASS-TRANSFER COEFFICIENT	kg	chemical-specific	cm/hr	Calculated	
MASS-TRANSFER COEFFICIENT	KL	chemical-specific	cm/hr	Calculated	
TEMPERATURE CORRECTION OF MASS-TRANSFER COEFFICIENT	Kal	chemical-specific	cm/hr	Calculated	
ANALYTE CONCENTRATION IN WATER DROPLET	Cwd	chemical-specific	ug/l	Calculated	
RELEASE RATE OF ANALYTE TO AIR	S	chemical-specific	ug/m3-min	Calculated	

Source: Foster, S.A. and Chrostowski, P.C., 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower.
 USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.
 [a] - Value for typical shower head, approximately 2.5 gal/min
 [b] - Assumes a room 6 feet wide, 6 feet long, and 6 feet high

Prepared by: JPK 2/17/2018
 Checked by: KALS 2/20/2018

TABLE D-1
 AIR CONCENTRATION OF VOCs WHILE SHOWERING - Property 1 and Property 2
 RECEPTOR: ADULT RESIDENT - CURRENT LAND USE
 Human Health Risk Assessment
 Olin OU3
 Wilmington, MA

Prepared by: JPK 2/17/2018
 Checked by: KALS 2/20/2018

ROOM AIR CONCENTRATIONS										
CHEMICALS OF POTENTIAL CONCERN	GROUND WATER CONCENTRATION (mg/l)	MOLECULAR WEIGHT (g/mol)	HENRY'S LAW CONSTANT (atm-m3/mol)	CHEMICAL-SPECIFIC MASS-TRANSFER COEFFICIENT (cm/hr)	CHEMICAL-SPECIFIC GAS MASS-TRANSFER COEFFICIENT (cm/hr)	MASS TRANSFER COEFFICIENT (cm/hr)	TEMPERATURE CORRECTION OF MASS- TRANSFER COEFFICIENT (cm/hr)	ANALYTE CONCENTRATION IN WATER DROPLET (ug/l)	RELEASE RATE OF ANALYTE TO AIR (ug/m ³ -min)	ROOM AIR CONCENTRATION (ug/m ³)
N-Nitrosodimethylamine - Property 1	1.5E-05	7.4E+01	1.8E-06	1.5E+01	1.5E+03	1.1E-01	1.5E-01	7.5E-05	1.2E-04	2.0E-03
N-Nitrosodimethylamine - Property 2	1.2E-05	7.4E+01	1.8E-06	1.5E+01	1.5E+03	1.1E-01	1.5E-01	6.1E-05	1.0E-04	1.6E-03

TABLE D-2
AIR CONCENTRATION OF VOCS WHILE SHOWERING - Property 1 and Property 2
RECEPTOR: CHILD RESIDENT - CURRENT LAND USE
Human Health Risk Assessment
Olin OU3
Wilmington, MA

EMPIRICAL CONSTANTS						EQUATIONS
PARAMETER	SYMBOL	VALUE	UNITS	SOURCE		
LIQUID-FILM MASS TRANSFER FOR CO2	Kl (CO2)	20	cm/hr	Calculated		$[OHM]ra = (S/R) \times (e^{(RDS)} - 1) \times e^{(-Rt)}$
GAS-FILM MASS TRANSFER FOR WATER	Kg (H2O)	3000	cm/hr	Calculated		
MOLAR GAS CONSTANT X TEMPERATURE	RT	0.024	atm-m ³ /mole			$k_l = Kl(CO2) \times (44/MW)^{1/2}$
REFERENCE TEMPERATURE	T1	293	K			$k_g = Kg(CO2) \times (18/MW)^{1/2}$
TEMPERATURE OF SHOWER WATER	Ts	318	K	Assumption		
VISCOSITY OF WATER AT SHOWER TEMPERATURE	us	0.596	Cp	Calculated		$K_L = (1/k_l + RT/Hk_g)^{-1}$
VISCOSITY OF WATER AT REFERENCE TEMPERATURE	u1	1.002	Cp	Calculated		
SHOWER DROPLET FREE-FALL TIME	ts	2.0	sec	Assumption		$K_{ad} = K_L \times ((T_1 \times u_{s1}) / (T_s \times u_l))^{-1/2}$
DROPLET DIAMETER	d	1	mm	Foster & Chrostowski, 1987		
FLOW RATE IN SHOWER	FR	10	l/min	Assumption [a]		$C_{ind} = C_w \times (1 - e^{-k_a \times t_1}) / (60d) \times 1000$
VOLUME OF SHOWER AREA	SV	6	m ³	Assumption [b]		
AIR EXCHANGE RATE	R	0.00833	min-1	Foster & Chrostowski, 1987		$S = C_{ind} \times FR / SV$
TIME IN SHOWER	Ds	16.2	min	Assumption		
TIME AT WHICH CONCENTRATION IS BEING CALCULATED	t	32.4	min	USEPA, 2014		
MOLECULAR WEIGHT	MW	chemical-specific	g/mol			
HENRY'S LAW CONSTANT	H	chemical-specific	atm-m ³ /mole			
CHEMICAL-SPECIFIC MASS-TRANSFER COEFFICIENT	kl	chemical-specific	cm/hr	Calculated		
CHEMICAL-SPECIFIC GAS MASS-TRANSFER COEFFICIENT	kg	chemical-specific	cm/hr	Calculated		
MASS-TRANSFER COEFFICIENT	KL	chemical-specific	cm/hr	Calculated		
TEMPERATURE CORRECTION OF MASS-TRANSFER COEFFICIENT	Kal	chemical-specific	cm/hr	Calculated		
ANALYTE CONCENTRATION IN WATER DROPLET	Cwd	chemical-specific	ug/l	Calculated		
RELEASE RATE OF ANALYTE TO AIR	S	chemical-specific	ug/m3-min	Calculated		

Source: Foster, S.A. and Chrostowski, P.C., 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower.
 USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.
 [a] - Value for typical shower head, approximately 2.5 gal/min
 [b] - Assumes a room 6 feet wide, 6 feet long, and 6 feet high

Prepared by: JPK 2/17/2018
 Checked by: KALS 2/20/2018

TABLE D-2
AIR CONCENTRATION OF VOCs WHILE SHOWERING - Property 1 and Property 2
RECEPTOR: CHILD RESIDENT - CURRENT LAND USE
Human Health Risk Assessment
Olin OU3
Wilmington, MA

Prepared by: JPK 2/17/2018
Checked by: KALS 2/20/2018

ROOM AIR CONCENTRATIONS

CHEMICALS OF POTENTIAL CONCERN	GROUND WATER CONCENTRATION N (mg/l)	MOLECULAR WEIGHT (g/mol)	HENRY'S LAW CONSTANT (atm-m3/mol)	CHEMICAL-SPECIFIC MASS-TRANSFER COEFFICIENT (cm/hr)	CHEMICAL- SPECIFIC GAS MASS- TRANSFER COEFFICIENT (cm/hr)	MASS TRANSFER COEFFICIENT (cm/hr)	TEMPERATURE CORRECTION OF MASS- TRANSFER COEFFICIENT (cm/hr)	ANALYTE CONCENTRATION IN WATER DROPLET (ug/l)	RELEASE RATE OF ANALYTE TO AIR (ug/m ³ -min)	ROOM AIR CONCENTRATION (ug/m ³)
N-Nitrosodimethylamine - Property 1	1.5E-05	7.4E+01	1.8E-06	1.5E+01	1.5E+03	1.1E-01	1.5E-01	7.5E-05	1.2E-04	1.6E-03
N-Nitrosodimethylamine - Property 2	1.2E-05	7.4E+01	1.8E-06	1.5E+01	1.5E+03	1.1E-01	1.5E-01	6.1E-05	1.0E-04	1.3E-03

Attachment E

Exposure Factors and Calculation of DAevent

TABLE E-1
EXPOSURE FACTORS - INGESTION AND DERMAL CONTACT, AND CALCULATION OF DAevent
Human Health Risk Assessment
Olin OU3
Wilmington, MA

EXPOSURE MEDIUM: GROUND WATER
EXPOSURE ROUTE: INGESTION AND DERMAL
EXPOSURE POINT: Property 1

CODE	EXPOSURE ASSUMPTION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	CHILD RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/MODEL NAME
IR-W	INGESTION RATE OF WATER	l/day	2.5	USEPA, 2014	0.78	USEPA, 2014	INTAKE-INGESTION (mg/kg/day) = CW x IR-W x FI x EF x ED x 1/BW x 1/AT
FI	FRACTION INGESTED	unitless	1	Assumption	1	Assumption	
t event	EXPOSURE TIME FOR BATHING/SHOWERING	hr/event	0.71	USEPA, 2014	0.54	USEPA, 2014	
EV	EVENT DAY	event/day	1	USEPA, 2014	1	USEPA, 2014	INTAKE-DERMAL (mg/kg/day) = SA x DAevent x EV x EF x ED x 1/BW x 1/AT
EF	EXPOSURE FREQUENCY	day/yr	350	USEPA, 2014	350	USEPA, 2014	
ED	EXPOSURE DURATION	yr	20	USEPA, 2014	6	USEPA, 2014	
BW	BODY WEIGHT	kg	80	USEPA, 2014	15	USEPA, 2014	Organic Compounds if ET<t*; DAevent = 2 x FA x CF x Kp x CW x $\sqrt{6 \times t \times ET / \pi}$
AT-C	AVERAGING TIME (CANCER)	day	25550	USEPA, 2014	25550	USEPA, 2014	
AT-N	AVERAGING TIME (NONCANCER)	day	7300	USEPA, 2014	2190	USEPA, 2014	
SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT DURING BATHING/SHOWERING	cm2	20900	USEPA, 2014	6378	USEPA, 2014	if ET> t*; DAevent =FA x CF x Kp x CW x [(ET/1 + B) + 2 x t x (1 + 3B + 3B2 / (1 + B)2)]
CF	CONVERSION FACTOR	l/cm3	0.001	-	0.001	-	
		-					Inorganic Compounds DAevent = Kp x CW x ET x CF

RME: Reasonable Maximum Exposure
USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.

			Dermal Contact								
EXPOSURE ROUTE	CHEMICAL OF POTENTIAL CONCERN	MEDIUM EPC VALUE POTABLE USE	Kp	B	t Event duration	t*	Fraction Absorbed	ADULT Exposure Time (ET>t*)	CHILD Exposure Time (ET>t*)	ADULT DAevent	CHILD DAevent
		Cw mg/l	(cm/hr)	(-)	(hr/event)	(hr)	(-)			mg/cm2-event	mg/cm2-event
INGESTION and DERMAL CONTACT	N-Nitrosodimethylamine	1.5E-05	2.5E-04	8.3E-04	2.7E-01	6.6E-01	1.0E+00	ET>t*	ET<t*	4.7E-12	4.0E-12
	N-Nitrosodi-n-propylamine	2.4E-05	2.3E-03	1.0E-02	5.6E-01	1.4E+00	1.0E+00	ET<t*	ET<t*	9.8E-11	8.5E-11
	Chloride	8.0E+01	NA	NA	NA	NA	NA	ET<t*	ET<t*	>EPD	>EPD
	Sulfate	2.7E+01	NA	NA	NA	NA	NA	ET<t*	ET<t*	>EPD	>EPD

EPD = Effective Predictive Domain.

Prepared by: JPK 2/16/2018
Checked by: KALS 2/20/2018

TABLE E-2
EXPOSURE FACTORS - INGESTION AND DERMAL CONTACT, AND CALCULATION OF DAevent
Human Health Risk Assessment
Olin OU3
Wilmington, MA

EXPOSURE MEDIUM: GROUND WATER
EXPOSURE ROUTE: INGESTION AND DERMAL
EXPOSURE POINT: Property 2

CODE	EXPOSURE ASSUMPTION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	CHILD RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/MODEL NAME
IR-W	INGESTION RATE OF WATER	l/day	2.5	USEPA, 2014	0.78	USEPA, 2014	INTAKE-INGESTION (mg/kg/day) = CW x IR-W x FI x EF x ED x 1/BW x 1/AT
FI	FRACTION INGESTED	unitless	1	Assumption	1	Assumption	
t event	EXPOSURE TIME FOR BATHING/SHOWERING	hr/event	0.71	USEPA, 2014	0.54	USEPA, 2014	
EV	EVENT DAY	event/day	1	USEPA, 2014	1	USEPA, 2014	
EF	EXPOSURE FREQUENCY	day/yr	350	USEPA, 2014	350	USEPA, 2014	INTAKE-DERMAL (mg/kg/day) = SA x DAevent x EV x EF x ED x 1/BW x 1/AT
ED	EXPOSURE DURATION	yr	20	USEPA, 2014	6	USEPA, 2014	
BW	BODY WEIGHT	kg	80	USEPA, 2014	15	USEPA, 2014	
AT-C	AVERAGING TIME (CANCER)	day	25550	USEPA, 2014	25550	USEPA, 2014	
AT-N	AVERAGING TIME (NONCANCER)	day	7300	USEPA, 2014	2190	USEPA, 2014	Organic Compounds if ET<t*; DAevent = 2 x FA x CF x Kp x CW x [6 x t x ET/ pi] Inorganic Compounds DAevent = Kp x CW x ET x CF
SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT DURING BATHING/SHOWERING	cm2	20900	USEPA, 2014	6378	USEPA, 2014	
CF	CONVERSION FACTOR	l/cm3	0.001	-	0.001	-	
		-					

RME: Reasonable Maximum Exposure
USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.

			Dermal Contact								
EXPOSURE ROUTE	CHEMICAL OF POTENTIAL CONCERN	MEDIUM EPC VALUE POTABLE USE	Kp	B	t Event duration	t*	Fraction Absorbed	ADULT Exposure Time (ET>t*)	CHILD Exposure Time (ET>t*)	ADULT DAevent	CHILD DAevent
		Cw									
		mg/l	(cm/hr)	(-)	(hr/event)	(hr)	(-)			mg/cm2-event	mg/cm2-event
INGESTION and DERMAL CONTACT	N-Nitrosodimethylamine	1.2E-05	2.5E-04	8.3E-04	2.7E-01	6.6E-01	1.0E+00	ET>t*	ET<t*	3.8E-12	3.2E-12
	Chloride	1.3E+02	NA	NA	NA	NA	NA	ET<t*	ET<t*	>EPD	>EPD
	Nitrate as N	1.9E+00	1.0E-03	--	--	--	--	NA	NA	1.4E-06	1.0E-06
	Sulfate	2.1E+01	NA	NA	NA	NA	NA	ET<t*	ET<t*	>EPD	>EPD

EPD = Effective Predictive Domain.

Prepared by: JPK 2/17/2018
Checked by: KALS 2/20/2018

TABLE E-3
EXPOSURE FACTORS - INHALATION OF SHOWER AIR
 Human Health Risk Assessment
 Olin OU3
 Wilmington, MA

MEDIUM: GROUND WATER EXPOSURE MEDIUM: AIR EXPOSURE ROUTE: INHALATION OF SHOWER AIR EXPOSURE POINT: Property 1 and Property 2

CODE	EXPOSURE ASSUMPTION	UNITS	ADULT RME VALUE	ADULT RATIONALE/ REFERENCE	CHILD RME VALUE	CHILD RATIONALE/ REFERENCE	INTAKE EQUATION
ET	EXPOSURE TIME	hr/day	0.71	USEPA, 2014	0.54	USEPA, 2014	AIR AVG. CONC. ($\mu\text{g}/\text{m}^3$) = $\text{CWair} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{IAF} \times 1/\text{AT} \times 1/\text{CF}$
EF	EXPOSURE FREQUENCY	day/yr	350	USEPA, 2014	350	USEPA, 2014	
ED	EXPOSURE DURATION	yr	20	USEPA, 2014	6	USEPA, 2014	
AT-C	AVERAGING TIME CANCER	day	25550	USEPA, 2014	25550	USEPA, 2014	
AT-N	AVERAGING TIME NONCANCER	day	7300	USEPA, 2014	2190	USEPA, 2014	Where CWair is modeled
CF	CONVERSION FACTOR	hr/day	24		24		
IAF	INHALATION ADJUSTMENT FACTOR	unitless	1	USEPA, 2014	1	USEPA, 2014	

RME: Reasonable Maximum Exposure.

USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.

Prepared by: JPK 2/16/2018

Checked by: KALS 2/20/2018

Attachment F

**USEPA Conditional Approval of Risk
Assessment Memorandum and Tables and
Figures to Support Uncertainty Analysis**

Attachment F

USEPA Conditional Approval of Risk Assessment Memorandum and Tables and Figures to Support Uncertainty Analysis

Copy of USEPA Letter dated May 22, 2018:

Conditional Approval

Human Health Risk Calculations for Potable Use of Private Residential Wells at Property 1 and Property 2 – Olin Chemical Superfund Site (“OU3”).

Olin Chemical Superfund Site, Wilmington, Massachusetts

Figures

Figure F-1 NDMA concentrations at Property 1 (M-24/L-54)

Figure F-2 NDMA concentrations at Property 2 (M-24/L-94)

Tables

Table F-1 Comparison of Data Sets and Exposure Point Concentrations for Entire and Recent Data Sets

Table F-2 ProUCL Output for Property 1 using 2015-2017 Data

Table F-3 ProUCL Output for Property 2 using 2015-2017 Data

Table F-4 ProUCL Output for Property 2 using 2015-2017 Data excluding maximum detected value

Table F-5 Calculation of Air Concentrations

Table F-6 MassDEP Risk Assessment for Resident Exposed to Chemicals in Drinking Water Shortform for Property 1

Table F-7 MassDEP Risk Assessment for Resident Exposed to Chemicals in Drinking Water Shortform for Property 2

Table F-8 Air Concentration of VOCs While Showering - Private Well - Property 1, using full duration shower operation

Table F-9 Air Concentration of VOCs While Showering - Private Well - Property 2, using full duration shower operation



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NEW ENGLAND – REGION 1
5 Post Office Square, Suite 100
Mail Code OSRR07-4
Boston, MA 02109-3912

May 22, 2018

Chinny Esakkiperumal
Olin Corporation
3855 North Ocoee Street
Suite 200
Cleveland, TN 37312

Subject: Conditional Approval
Human Health Risk Calculations for Potable Use of Private Residential Wells at
[REDACTED] – Olin Chemical Superfund Site ("OU3").
Olin Chemical Superfund Site, Wilmington, Massachusetts

Dear Mr. Esakkiperumal,

In accordance with Paragraph 40 of the Administrative Settlement Agreement and Order on Consent ("AOC"), Region I of the United States Environmental Protection Agency ("EPA") has completed a review of the above referenced Memorandum prepared by Michael Murphy and Peter Thompson on March 6, 2018 (the "Memorandum").

The Memorandum summarizes the preliminary human health risk assessment for potable use of groundwater from private wells at residences located at [REDACTED] and [REDACTED]. EPA requested that Olin prepare this Memorandum because of the recent recognition that NDMA is sufficiently volatile and now has an inhalation component in the EPA Regional Screening Level ("RSL") for tap water that lowered the RSL below the screening value previously used. NDMA has also been detected in other private wells, however EPA agrees that the two wells evaluated in the Memorandum represent the only locations with consistently detected concentrations near or above the current RSL for NDMA which is 11 nanograms per liter ("ng/l").

The Memorandum provides data from the two residential wells dating from 1995 through 2017, selects Contaminants of Potential Concern ("COPCs") based on EPA ("Regional Screening Levels") RSLs, calculates the 95% UCLs to determine exposure point concentrations using ProUCL, and calculates reasonable maximum exposure ("RME") risks at each property separately from exposures to groundwater as drinking water through ingestion, dermal exposures while showering or bathing, and inhalation of volatile COPCs while showering/bathing. The Memorandum follows RAGS D and provides good detail and explanation of the approaches used. Identified COPCs were limited to NDMA, N-nitrosodipropylamine, and nitrate. NDMA is the only COPC evaluated for inhalation exposures. Final cancer risks at both properties were 3×10^{-5} and chronic child hazard indices were 0.09 and 0.1.

EPA concurs with the inhalation risk assessment of the two detected nitrosamines for the two active private well users on [REDACTED] as presented in the Memorandum, subject to the following Conditions and Comments.

Conditions

1. **ATSDR Volatilization Risk Model** – The currently available inhalation models (Foster and Chrostowski, 1986 and Andelman 1990), are dated. EPA understands that the ATSDR has been developing an updated volatilization model which they expect to release later this year. *EPA will revisit this issue at that time and may request that Olin supplement the Memorandum with an updated inhalation risk assessment based on the ATSDR model.*
2. **Volatilization Factors** - Olin/AMEC shall provide estimated volatilization factors (VF) for the two nitrosamines, comparable to the type(s) of VF used in the Foster & Chrostowski (1985) shower model and the Andelman (1986) whole house water use model, so that the RME concentrations of the two chemicals could be entered into the ATSDR model after it is released. *Since the approach used by AMEC is similar to that used in the MCP Method 1 risk assessment spreadsheet, please add a discussion and documentation in the uncertainty section concerning the results of AMEC's evaluation relative to the results using the MCP spreadsheet.*

General Comments

1. **Water to Air Transfer model** - To calculate inhalation exposures, the Memorandum uses a showering model (Foster and Chrostowski, 1986) used by MassDEP in developing their MCP-GW-1 standards; rather than using the inhalation of vapors during household water use model (Andelman, 1990) currently used in the developing the inhalation portion of the EPA tapwater RSLs. Both models have been used in HHRAs over the last 20+ years. The advantage of the Andelman model is its' simplicity, but also that it covers exposures to volatiles from all household water uses (showering and bathing, but also laundry, cooking, dishwashing, etc.). The Foster & Chrostowski model is strictly for exposures while showering. Both of these models are dated. *In the Uncertainties Section, the revised Memorandum should include calculations of the inhalation exposures using the Andelman model with an adjusted volatilization constant K at the low end of Andelman's range (perhaps 0.01 L/m³). Results should be discussed.*
2. **Exposure Point Concentrations (“EPCs”)** - The EPCs used for this assessment are 95% UCLs calculated using private well data collected from 1995 through 2017. In general, EPA guidance recommends using data from the most recent sampling. The goal is to have at least 10 results in order to calculate statistically valid 95%UCLs using ProUCL. For both of the subject wells, quarterly data exists back to 2009. *In the Uncertainties Section, the EPCs should be re-calculated limiting the data set to resulted measured within the last 3 years only. The revised Memorandum should discuss whether use of the revised EPCs would change the conclusions.*
3. **Exposure Assumptions** - Because of the selection of the Foster and Chrostowski model, inhalation exposure times are limited to time spent in the bathroom during showering (EPA default showering/bathing time is 43 minutes (0.7 hr) for adults and 32 minutes (0.54 hr) for children), as opposed to 24 hr/day exposure to household air. In addition, the Memorandum assumes the shower is only running for 1/2 that time and so

uses 1/2 the EPA recommended default showering exposure times within the model to develop the air concentration. Exposure times are shown in Table E-3 as the default values; however it is within calculation of the air concentration that this reduction in time has been carried out. Although this may be appropriate for a CTE evaluation, the model should use the full default exposure time to calculate the indoor air EPC while showering for an RME evaluation. *In the Uncertainties Section, the revised Memorandum should include calculations for the RME evaluation which are based on the full (non-adjusted) default exposer times. Results should be discussed.*

Please submit the revised Memorandum to EPA by Friday, June 8th. Call me if you have any questions.

Sincerely,



James M. DiLorenzo
Remedial Project Manager
USEPA Region 1 - New England

Cc: Rick Sugatt, EPA
Lynne Jennings, EPA
Chris Smith, EPA
Jeff Brunelle, Nobis
Garry Waldeck, MassDEP
Jeff Hull, Town of Wilmington
Michael Webster, GeoInsight
Martha Stevenson, WERC

Figure F-1: NDMA concentrations at Property 1

*unfilled circles indicate non-detect values

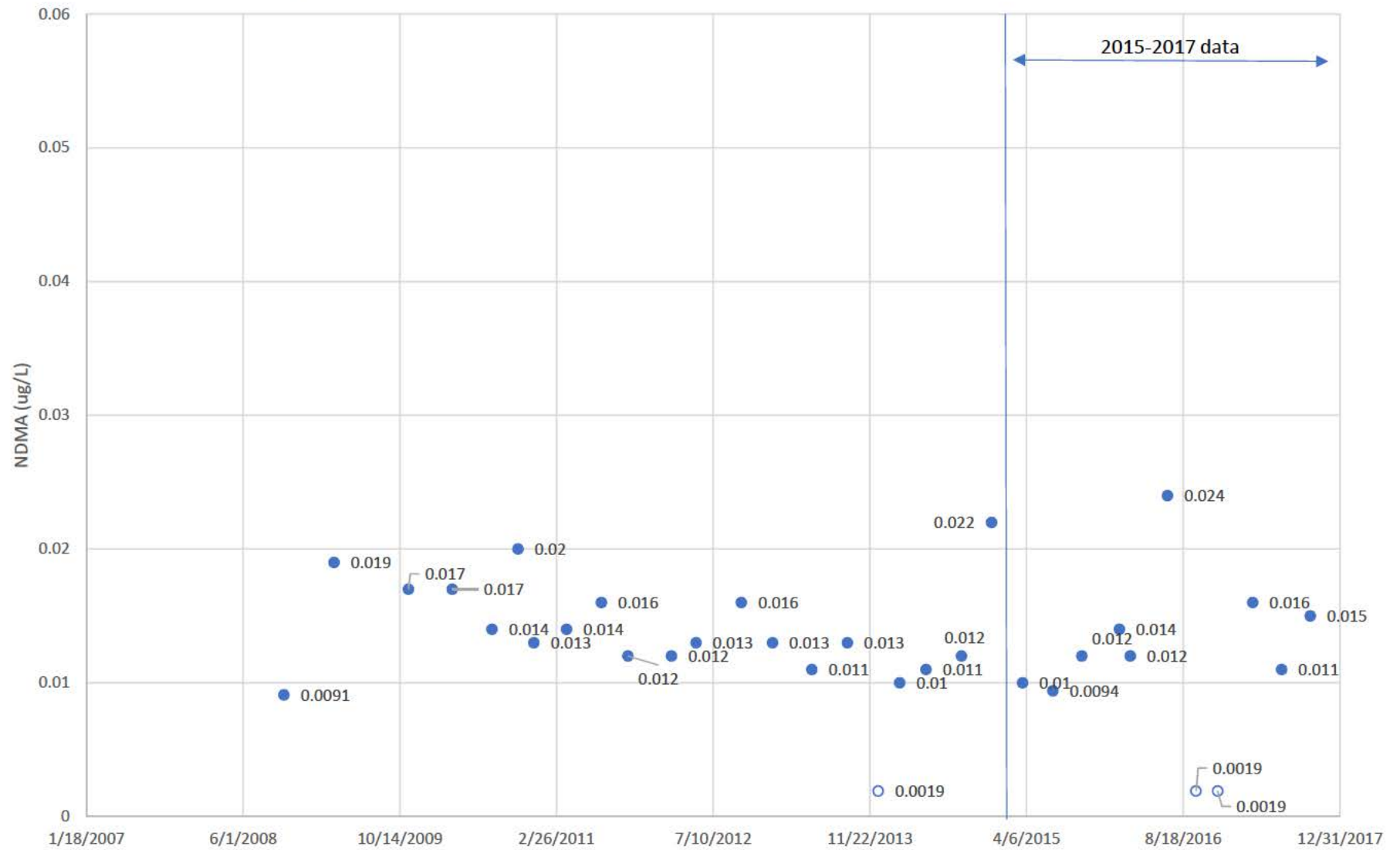


Figure F-2: NDMA concentrations at Property 2

*unfilled circles indicate non-detect values

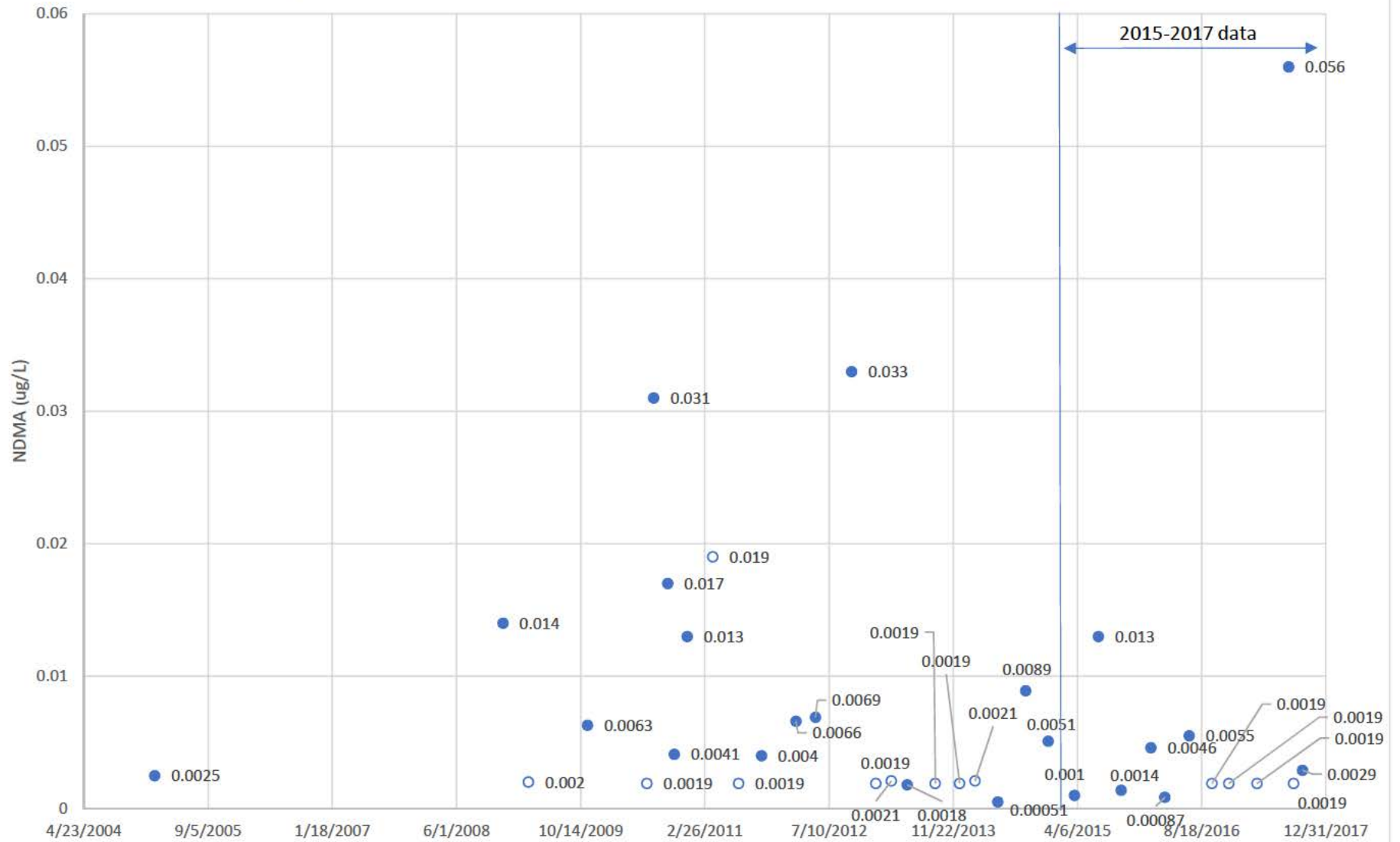


Table F-1
Comparison of Data Sets and Exposure Point Concentrations for Entire and Recent Data Sets
Property 1 and Property 2
Olin OU3
Wilmington, MA

	Property 1 (2008-2017)	Property 1 (2015-2017)	Property 2 (2005-2017)	Property 2 (2015-2017)	Property 2 (2015-2017) (excluding max detect)
Frequency of detection	91%	82%	64%	67%	64%
Range of detected concentrations (µg/L)	0.0091 - 0.024	0.0094 - 0.024	0.00051 - 0.056	0.00087 - 0.056	0.00087 - 0.013
UCL(s) (µg/L)	0.0147, 0.0149	0.015	0.0121	0.0604, 0.056 (max), 0.0353	0.00513
Recommended EPC (µg/L)	0.0149	0.015	0.0121	0.0353	0.00513
Basis	95% GROS Adjusted Gamma UCL	95% KM (t) UCL	Gamma Adjusted KM-UCL	Gamma Adjusted KM-UCL	95% KM (t) UCL

Prepared by: JPK 6/5/2018

Checked by: LGF 6/5/2018

Table F-2
ProUCL Output using 2015-2017 Data
Property 1
Olin OU3
Wilmington, MA

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.15/25/2018 12:39:51 PM
From File Property_3rys.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

N-Nitrosodimethylamine (m-24/l-54)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	9
		Number of Missing Observations	1
Number of Detects	9	Number of Non-Detects	2
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.0094	Minimum Non-Detect	0.0019
Maximum Detect	0.024	Maximum Non-Detect	0.0019
Variance Detects	1.9801E-5	Percent Non-Detects	18.18%
Mean Detects	0.0137	SD Detects	0.00445
Median Detects	0.012	CV Detects	0.325
Skewness Detects	1.718	Kurtosis Detects	3.519
Mean of Logged Detects	-4.329	SD of Logged Detects	0.287

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.838	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.205	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0116	KM Standard Error of Mean	0.0019
KM SD	0.00593	95% KM (BCA) UCL	0.0144
95% KM (t) UCL	0.015	95% KM (Percentile Bootstrap) UCL	0.0145
95% KM (z) UCL	0.0147	95% KM Bootstrap t UCL	0.0147
90% KM Chebyshev UCL	0.0173	95% KM Chebyshev UCL	0.0198
97.5% KM Chebyshev UCL	0.0234	99% KM Chebyshev UCL	0.0304

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.392	Anderson-Darling GOF Test
5% A-D Critical Value	0.722	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.84	k star (bias corrected MLE)	8.632
Theta hat (MLE)	0.00107	Theta star (bias corrected MLE)	0.00159
nu hat (MLE)	231.1	nu star (bias corrected)	155.4
Mean (detects)	0.0137		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0094	Mean	0.013
Maximum	0.024	Median	0.012
SD	0.00425	CV	0.326

Table F-2
ProUCL Output using 2015-2017 Data
Property 1
Olin OU3
Wilmington, MA

k hat (MLE)	12.92	k star (bias corrected MLE)	9.456
Theta hat (MLE)	0.00101	Theta star (bias corrected MLE)	0.00138
nu hat (MLE)	284.2	nu star (bias corrected)	208
Adjusted Level of Significance (β)	0.0278		
Approximate Chi Square Value (208.02, α)	175.6	Adjusted Chi Square Value (208.02, β)	170.8
95% Gamma Approximate UCL (use when $n \geq 50$)	0.0154	95% Gamma Adjusted UCL (use when $n < 50$)	0.0159

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0116	SD (KM)	0.00593
Variance (KM)	3.5153E-5	SE of Mean (KM)	0.0019
k hat (KM)	3.804	k star (KM)	2.827
nu hat (KM)	83.68	nu star (KM)	62.19
theta hat (KM)	0.00304	theta star (KM)	0.00409
80% gamma percentile (KM)	0.0166	90% gamma percentile (KM)	0.0208
95% gamma percentile (KM)	0.0247	99% gamma percentile (KM)	0.0332

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (62.19, α)	45.06	Adjusted Chi Square Value (62.19, β)	42.69
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	0.016	95% Gamma Adjusted KM-UCL (use when $n < 50$)	0.0168

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.925	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.184	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0124	Mean in Log Scale	-4.455
SD in Original Scale	0.00491	SD in Log Scale	0.381
95% t UCL (assumes normality of ROS data)	0.0151	95% Percentile Bootstrap UCL	0.0149
95% BCA Bootstrap UCL	0.0151	95% Bootstrap t UCL	0.0162
95% H-UCL (Log ROS)	0.016		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.681	KM Geo Mean	0.00927
KM SD (logged)	0.786	95% Critical H Value (KM-Log)	2.608
KM Standard Error of Mean (logged)	0.251	95% H-UCL (KM -Log)	0.0241
KM SD (logged)	0.786	95% Critical H Value (KM-Log)	2.608
KM Standard Error of Mean (logged)	0.251		

DL/2 Statistics

DL/2 Normal

Mean in Original Scale	0.0114
SD in Original Scale	0.00652
95% t UCL (Assumes normality)	0.015

DL/2 Log-Transformed

Mean in Log Scale	-4.807
SD in Log Scale	1.094
95% H-Stat UCL	0.0447

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.015

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation ProUCL 5.15/25/2018 12:39:51 PM
From File Property_3rys.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

N-Nitrosodimethylamine (m-24/l-94)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	9
		Number of Missing Observations	2
Number of Detects	8	Number of Non-Detects	4
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	8.7000E-4	Minimum Non-Detect	0.0019
Maximum Detect	0.056	Maximum Non-Detect	0.0019
Variance Detects	3.5138E-4	Percent Non-Detects	33.33%
Mean Detects	0.0107	SD Detects	0.0187
Median Detects	0.00375	CV Detects	1.759
Skewness Detects	2.596	Kurtosis Detects	6.922
Mean of Logged Detects	-5.522	SD of Logged Detects	1.411

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.586	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.358	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00747	KM Standard Error of Mean	0.00463
KM SD	0.015	95% KM (BCA) UCL	0.0161
95% KM (t) UCL	0.0158	95% KM (Percentile Bootstrap) UCL	0.0158
95% KM (z) UCL	0.0151	95% KM Bootstrap t UCL	0.0604
90% KM Chebyshev UCL	0.0214	95% KM Chebyshev UCL	0.0277
97.5% KM Chebyshev UCL	0.0364	99% KM Chebyshev UCL	0.0536

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.619	Anderson-Darling GOF Test	
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.262	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.307	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.626	k star (bias corrected MLE)	0.475
Theta hat (MLE)	0.017	Theta star (bias corrected MLE)	0.0225
nu hat (MLE)	10.02	nu star (bias corrected)	7.593
Mean (detects)	0.0107		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.7000E-4	Mean	0.0104
Maximum	0.056	Median	0.00775

Table F-3
ProUCL Output using 2015-2017 Data
Property 2
Olin OU3
Wilmington, MA

SD	0.015	CV	1.433
k hat (MLE)	0.894	k star (bias corrected MLE)	0.726
Theta hat (MLE)	0.0117	Theta star (bias corrected MLE)	0.0144
nu hat (MLE)	21.46	nu star (bias corrected)	17.43
Adjusted Level of Significance (β)	0.029		
Approximate Chi Square Value (17.43, α)	8.977	Adjusted Chi Square Value (17.43, β)	8.067
95% Gamma Approximate UCL (use when $n \geq 50$)	0.0203	95% Gamma Adjusted UCL (use when $n < 50$)	0.0225

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00747	SD (KM)	0.015
Variance (KM)	2.2534E-4	SE of Mean (KM)	0.00463
k hat (KM)	0.248	k star (KM)	0.241
nu hat (KM)	5.942	nu star (KM)	5.79
theta hat (KM)	0.0302	theta star (KM)	0.031
80% gamma percentile (KM)	0.0107	90% gamma percentile (KM)	0.0225
95% gamma percentile (KM)	0.0365	99% gamma percentile (KM)	0.0742

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.79, α)	1.533	Adjusted Chi Square Value (5.79, β)	1.225
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	0.0282	95% Gamma Adjusted KM-UCL (use when $n < 50$)	0.0353

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.929	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.16	Lilliefors GOF Test
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00749	Mean in Log Scale	-5.999
SD in Original Scale	0.0157	SD in Log Scale	1.382
95% t UCL (assumes normality of ROS data)	0.0156	95% Percentile Bootstrap UCL	0.0156
95% BCA Bootstrap UCL	0.0203	95% Bootstrap t UCL	0.0604
95% H-UCL (Log ROS)	0.0295		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.962	KM Geo Mean	0.00257
KM SD (logged)	1.249	95% Critical H Value (KM-Log)	3.388
KM Standard Error of Mean (logged)	0.389	95% H-UCL (KM -Log)	0.0201
KM SD (logged)	1.249	95% Critical H Value (KM-Log)	3.388
KM Standard Error of Mean (logged)	0.389		

DL/2 Statistics

DL/2 Normal

Mean in Original Scale	0.00742
SD in Original Scale	0.0157
95% t UCL (Assumes normality)	0.0156

DL/2 Log-Transformed

Mean in Log Scale	-6.001
SD in Log Scale	1.329
95% H-Stat UCL	0.0248

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL	0.0604	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	0.0353
------------------------	--------	---	--------

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Table F-4
ProUCL Output using 2015-2017 Data excluding maximum detected value
Property 2
Olin OU3
Wilmington, MA

N-Nitrosodimethylamine (m-24/l-94)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	8
		Number of Missing Observations	3
Number of Detects	7	Number of Non-Detects	4
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	8.7000E-4	Minimum Non-Detect	0.0019
Maximum Detect	0.013	Maximum Non-Detect	0.0019
Variance Detects	1.8358E-5	Percent Non-Detects	36.36%
Mean Detects	0.00418	SD Detects	0.00428
Median Detects	0.0029	CV Detects	1.025
Skewness Detects	1.768	Kurtosis Detects	3.374
Mean of Logged Detects	-5.9	SD of Logged Detects	0.997

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.798	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.236	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00306	KM Standard Error of Mean	0.00114
KM SD	0.0035	95% KM (BCA) UCL	0.00535
95% KM (t) UCL	0.00513	95% KM (Percentile Bootstrap) UCL	0.00494
95% KM (z) UCL	0.00493	95% KM Bootstrap t UCL	0.00742
90% KM Chebyshev UCL	0.00648	95% KM Chebyshev UCL	0.00803
97.5% KM Chebyshev UCL	0.0102	99% KM Chebyshev UCL	0.0144

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.316	Anderson-Darling GOF Test
5% A-D Critical Value	0.723	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.318	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.326	k star (bias corrected MLE)	0.853
Theta hat (MLE)	0.00315	Theta star (bias corrected MLE)	0.0049
nu hat (MLE)	18.56	nu star (bias corrected)	11.94
Mean (detects)	0.00418		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.7000E-4	Mean	0.0063
Maximum	0.013	Median	0.0055
SD	0.00443	CV	0.704
k hat (MLE)	1.53	k star (bias corrected MLE)	1.173
Theta hat (MLE)	0.00412	Theta star (bias corrected MLE)	0.00537
nu hat (MLE)	33.65	nu star (bias corrected)	25.81
Adjusted Level of Significance (β)	0.0278		

Table F-4
ProUCL Output using 2015-2017 Data excluding maximum detected value
Property 2
Olin OU3
Wilmington, MA

Approximate Chi Square Value (25.81, α)	15.23	Adjusted Chi Square Value (25.81, β)	13.92
95% Gamma Approximate UCL (use when $n \geq 50$)	0.0107	95% Gamma Adjusted UCL (use when $n < 50$)	0.0117

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00306	SD (KM)	0.0035
Variance (KM)	1.2243E-5	SE of Mean (KM)	0.00114
k hat (KM)	0.763	k star (KM)	0.616
nu hat (KM)	16.8	nu star (KM)	13.55
theta hat (KM)	0.004	theta star (KM)	0.00496
80% gamma percentile (KM)	0.00504	90% gamma percentile (KM)	0.0079
95% gamma percentile (KM)	0.0109	99% gamma percentile (KM)	0.0181

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (13.55, α)	6.263	Adjusted Chi Square Value (13.55, β)	5.476
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	0.00661	95% Gamma Adjusted KM-UCL (use when $n < 50$)	0.00756

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.941	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.178	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00309	Mean in Log Scale	-6.242
SD in Original Scale	0.00366	SD in Log Scale	0.956
95% t UCL (assumes normality of ROS data)	0.00509	95% Percentile Bootstrap UCL	0.0051
95% BCA Bootstrap UCL	0.00601	95% Bootstrap t UCL	0.00757
95% H-UCL (Log ROS)	0.00741		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.242	KM Geo Mean	0.00195
KM SD (logged)	0.873	95% Critical H Value (KM-Log)	2.761
KM Standard Error of Mean (logged)	0.291	95% H-UCL (KM -Log)	0.0061
KM SD (logged)	0.873	95% Critical H Value (KM-Log)	2.761
KM Standard Error of Mean (logged)	0.291		

DL/2 Statistics

DL/2 Normal

Mean in Original Scale	0.00301
SD in Original Scale	0.0037
95% t UCL (Assumes normality)	0.00503

DL/2 Log-Transformed

Mean in Log Scale	-6.285
SD in Log Scale	0.939
95% H-Stat UCL	0.00682

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.00513

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Table F-5
Calculation of Air Concentrations
Property 1 and Property 2
Olin OU3
Wilmington, MA

	Property 1	Property 2
Groundwater EPC (µg/L)	0.0149	0.0121
Foster & Chrostowski Shower Air Concentration (µg/m ³) (from Table D-1)	0.002	0.0016
Andelman whole-house 24-hour air concentration - non-cancer (µg/m ³) ¹	0.000149	0.000121
Foster & Chrostowski whole-house 24-hour air concentration - non-cancer (µg/m ³) ²	0.000059	0.000047
Andelman whole house 24-hour air concentration - cancer (lifetime) (µg/m ³) ³	0.000055	0.000045
Foster & Chrostowski whole-house 24-hour air concentration - cancer (lifetime) (µg/m ³) ³	0.000022	0.000018

Notes:

1. $C_{air\ nc} = C_{water} * K$, where $K = 0.01\ L/m^3$
2. $C_{air\ nc} = C_{shower\ air} * (0.71\ hr/24\ hr)$
3. $C_{air\ c} = C_{air\ nc} * (26\ yr/70\ yr)$

Prepared by: JPK 6/7/2018

Checked by: LGF 6/8/2018

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Method 3 Risk Assessment for Resident Exposed to Chemicals in Drinking Water - Shortform 2012 (sf12rw)

Index

Tab

EPCs	Table RW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table RW-2: Equations to calculate cancer risks.
NC Eq	Table RW-3: Equations to calculate noncancer risks.
DA Eq	Table RW-4: Equations to calculate Absorbed Dermal Dose.
DA	Table RW-5: Dermal Absorbed Dose from Showering
IECs Eq	Table RW-6: Equations to calculate Inhalation Exposure Concentrations in the shower.
IECs	Table RW-7: Inhalation Exposure Concentration in the Shower
Exp	Table RW-8: Definitions and exposure factors.
Chem	Table RW-9: Chemical-specific data.

Spreadsheets designed by Andrew Friedmann, MassDEP

Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection

Office of Research and Standards

One Winter Street

Boston, MA 02108 USA

Telephone: (617) 556-1165

Fax: (617) 556-1006

Email: Lydia.Thompson@state.ma.us

Table F-6
 MassDEP Risk Assessment Shortform
 Property 1
 Olin OU3
 Wilmington, MA

Resident - Drinking Water: Table RW-1
Exposure Point Concentration (EPC) and Risk
Based on Resident Ages 1-31 (Cancer) and 1-8 (Noncancer)

ShortForm Version 10-12
 Vlookup Version v0315

Property 1

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 1.5E-05

HI (all chemicals) =

Oil or Hazardous Material (OHM)	EPC (µg/L)	ELCR ingestion	ELCR dermal	ELCR inhalation	ELCR _{total}	Chronic			HQ _{total}
						HQ _{ing}	HQ _{derm}	HQ _{inh}	
N-NITROSOD METHYLAMINE (NDMA)	1.5E-02	1.4E-05	3.2E-08	7.4E-07	1.5E-05				

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-2
Equations to Calculate Cancer Risk for Resident (Age 1-31 years)

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1-31)} * CSF$$

$$LADD_{ing(1-31)} = LADD_{ing(1-8)} + LADD_{ing(8-15)} + LADD_{ing(15-31)}$$

$$LADD_{ing(age\ group\ x)} = \frac{EPC * VI_x * RAF_{c-ing} * EF * ED_{ing} * EP_x * C}{BW_x * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm(1-31)} * CSF$$

$$LADD_{derm(1-31)} = LADD_{derm(1-8)} + LADD_{derm(8-15)} + LADD_{derm(15-31)}$$

$$LADD_{derm(age\ group\ x)} = \frac{DA_x * SA_x * EF * ED_{derm} * EP_x}{OAE_c * BW_x * AP_{lifetime}}$$

or, if outside "Effective Predictive Domain", then

$$LADD_{derm(age\ group\ x)} = DM * LADD_{ing(age\ group\ x)}$$

Cancer Risk from Inhalation

$$ELCR_{inh} = LADE_{(1-31)} * URF$$

$$LADE_{(1-31)} = LADE_{(1-8)} + LADE_{(8-15)} + LADE_{(15-31)}$$

$$LADE_{(age\ x)} = \frac{IEC_{S-x} * EF * ED_{inh-x} * EP_x}{AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
URF	OHM-specific	(µg/m ³) ⁻¹
LADD	age/OHM-specific	mg/kg-day
LADE	age/OHM-specific	µg/m ³
EPC	OHM-specific	µg/L
VI ₍₁₋₈₎	1	L/day
VI ₍₈₋₁₅₎	2	L/day
VI ₍₁₅₋₃₁₎	2	L/day
RAF _{c-ing}	OHM-specific	dimensionless
EF	1.00	event/day
ED _{ing & derm}	1	day/event
ED _{inh(1-8)}	0.046	day/event
ED _{inh(8-15)}	0.046	day/event
ED _{inh(15-31)}	0.044	day/event
EP ₍₁₋₈₎	7	years
EP ₍₈₋₁₅₎	7	years
EP ₍₁₅₋₃₁₎	16	years
C	0.001	mg/µg
BW ₍₁₋₈₎	17.0	kg
BW ₍₈₋₁₅₎	39.9	kg
BW ₍₁₅₋₃₁₎	58.7	kg
AP _(lifetime)	70	years
IEC _{S-x}	age/OHM-specific	µg/m ³
DA _x	age/OHM-specific	mg/cm ² -day
OAE _c	OHM-specific	dimensionless
SA ₍₁₋₈₎	7130	cm ²
SA ₍₈₋₁₅₎	12800	cm ²
SA ₍₁₅₋₃₁₎	16731	cm ²
DM	OHM-specific	dimensionless

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-3
Equations to Calculate Noncancer Risk for Resident Child (Age 1-8 years)

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{EPC * VI * RAF_{nc-ing} * EF * ED_{ing} * EP * C}{BW * AP}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD}$$

$$ADD_{derm} = \frac{DA * SA * EF * ED_{derm} * EP}{OAE_{nc} * BW * AP}$$

or, if DA is outside the "Effective Predictive Domain" of the dermal model, then

$$ADD_{derm} = DM * ADD_{ing}$$

Noncancer Risk from Inhalation

$$HQ_{inh} = \frac{ADE}{RfC}$$

$$ADE = \frac{IEC_S * EF * ED_{inh} * EP * C}{AP}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
RfC	OHM-specific	mg/m ³
ADD _{ing}	OHM-specific	mg/kg-day
ADD _{derm}	OHM-specific	mg/kg-day
ADE	OHM-specific	mg/m ₃
EPC	OHM-specific	µg/L
VI	1	L/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
EF	1.00	event/day
ED _{ing}	1	day/event
ED _{derm}	1	day/event
ED _{inh}	0.046	day/event
EP	7	years
C	0.001	mg/µg
BW	17.0	kg
AP _(noncancer)	7	years
IEC _S	OHM-specific	µg/m ³
DA	OHM-specific	mg/cm ² -day
OAE _{nc}	OHM-specific	dimensionless
SA	7130	cm ²
DM	OHM-specific	dimensionless

Resident - Drinking Water: Table RW-4
Equations to Calculate Absorbed Dermal Dose from Showering (DA)

Vlookup Version v0315

Model equations obtained from U.S. EPA (2001) Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim (<http://www.epa.gov/oswer/riskassessment/rags/index.htm>).

Steady State versus Non-Steady State for Organic Chemicals: The time for an organic chemical to reach steady state is a function of the chemical's molecular weight (MW) and its ability to traverse skin (expressed as a permeability constant, Kp). If an organic chemical does not reach steady state before the shower is over (i.e., time to reach steady state, t^* , is greater than the shower duration, D_s), Equation (1) is used to calculate the dermal dose for this non-steady state. For organic chemicals that have reached a steady state by the end of the shower, Equation (2) is used to calculate dermal dose.

Effective Predictive Domain: The model is not used for organic chemicals that fall outside its effective predictive domain. Strictly, chemicals with very large or very small Kow values are outside of the EPD. Chemicals outside the Effective Predictive Domain are identified with an asterisk in Tables B-2 and B-3 in the above citation as well as in Table V4 in the Vlookup (V) workbook. For these chemicals, the dermal dose is estimated as a function of the oral dose according to MA DEP (1995) Guidance for Disposal Site Risk Characterization and Equation (3) below. Note that the dermal dose in these cases is calculated as an average daily dose (ADD) or life-time average daily dose (LADD) and expressed in mg/kg-bw. Equation (3) is also presented in Tables DW-2 and DW-3.

(1) Organic Chemicals Inside Effective Predictive Domain - Non-Steady State

Equation for estimating dermally absorbed dose (DA) for organic chemicals when the shower duration (D_s) is less than or equal to the time to reach steady state (t^*).

$$DA = 2 * FA * C * Kp * Cw * [(6 * t^* D_s) / p]^{1/2}$$

(2) Organic Chemicals Inside Effective Predictive Domain - Steady State

Equation for estimating DA for organic chemicals when D_s is greater than the time to reach t^* .

$$DA = FA * C * Kp * Cw * [(D_s / (1+B)) + 2 * t^* ((1+3B+3B^2) / (1+B)^2)]$$

(3) Organic Chemicals Outside Effective Predictive Domain

$$(L)ADD_{derm} = DM * (L)ADD_{ing}$$

(4) Inorganic Chemicals

Equation for estimating DA for inorganic chemicals in water.

$$DA = C * Kp * Cw * D_s$$

Where the equations to calculate the input values are:

(a) Equation for predicting stratum corneum permeability constant (Kp) for organic chemicals:

$$Kp = 10^{[-2.8 + (0.66 * \log Kow) - (0.0056 * MW)]}$$

(b) Equation for calculating ratio of permeability of chemical in stratum corneum to permeability in viable epidermis (B)

$$B = Kp * ((MW)^{1/2} / 2.6)$$

(c) Calculations for calculating time to reach steady state (t^*):

When B is less than or equal to 0.6

$$t^* = 2.4 * t$$

When B is greater than 0.6

$$t^* = (b - (b^2 - c^2)^{1/2}) * I_{sc}^2 / D_{sc}$$

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-4
Equations to Calculate Absorbed Dermal Dose from Showering (DA)

Vlookup Version v0315

(d) Equations for calculating b and c

$$c = (1 + 3B + 3B^2) / (3 * (1+B)) \quad b = (2(1+B)^2 / p) - c$$

(e) Equation for calculating lag time (t)

$$t = l_{sc}^2 / (6 * D_{sc})$$

(f) Equation for calculating effective diffusivity (D_{sc})

$$D_{sc} = 10^{-2.8 - (0.0056 * MW)} * l_{sc}$$

Parameter	Value	Units	Notes
DA _{event} - Absorbed dose per event per area skin exposed	calculated	mg/cm ² -day	see Table RW-4 and RW-5
FA - Fraction absorbed	OHM-specific	dimensionless	see Table RW-5
Kp - Stratum corneum (sc) permeability constant	OHM-specific	cm/hr	see Table RW-9
C - Conversion Factor	0.000001	m ³ /cm ³	
C _w - [OHM] in water, Exposure Point Concentration	OHM-specific	mg/m ³	see Table RW-1, expressed as µg/L
t - Lag time	calculated	hrs	Time for chemical to cross stratum corneum (Table RW-5)
D _s - Shower Duration	age-specific	hrs	see Table RW-6
LogK _{ow} - Octanol/water partition coefficient	OHM-specific	dimensionless	see Table RW-9
MW - Molecular Weight	OHM-specific	g/mole	see Table RW-9
t* - Time to reach steady state	calculated	hr	see Table RW-5
b - Empirical variable used to calculate t*	calculated	dimensionless	see Table RW-5
c - Empirical variable used to calculate t*	calculated	dimensionless	see Table RW-5
l _{sc} - Thickness of skin	0.001	cm	MA DEP (1995). Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
D _{sc} - Effective diffusivity for chemical transfer through the skin	calculated	cm ² /hr	see Table RW-5
B - Ratio of permeability of chemical in stratum corneum to permeability of chemical in viable epidermis	calculated	dimensionless	see Table RW-5

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-5
Dermal Absorbed Dose (DA) from Showering

Vlookup Version v0315

Oil or Hazardous Material	Ratio of perm. in stratum corneum to viable epidermis B	Lag Time (tau) hours	Effective Diffusivity of Chemical Transfer Through Skin Dsc (cm ² /hr)	Time to Reach Steady State t* hours	t* when B>0.6 hours	b	c	Absorbed Dose (1-8) DA (mg/cm ² -day)	Absorbed Dose (8-15) DA (mg/cm ² -day)	Absorbed Dose (15-31) DA (mg/cm ² -day)	Outside Effective Predictive Domain	Fraction Absorbed FA	Absorbed Dose (1-8) w/ FA term DA(1-8) (mg/cm ² -day)	Absorbed Dose (8-16) w/ FA term DA(8-16) (mg/cm ² -day)	Absorbed Dose (16-31) w/ FA term DA(16-31) (mg/cm ² -day)	Dermal Mult. DM
N-NITROSOD METHYLAMINE (NDMA)	8.49E-04	0.273	6.10E-07	0.66		3.0E-01	3.3E-01	5.00E-12	4.77E-12	4.08E-12		1	5.00E-12	4.77E-12	4.08E-12	

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-6
Equations to Calculate Inhalation Exposure Concentration in the Shower (IEC_s)

Vlookup Version v0315

Model equations obtained from Foster, S.A. and Chrostowski, P.C. (1987) Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presentation at the 80th Annual Meeting of APCA. New York, NY. June 21-26, 1987.

(1) Inhalation Exposure Concentration in the Shower.

$$IECs = [(S/R_{ae}) * (D_s + (e^{-R_{ae}Dt}/R_{ae}) - (e^{R_{ae}(Ds-Dt)}/R_{ae}))] / D_t$$

Where the equations to calculate the input values are:

(a) Indoor Air Generation Rate

$$S = (C_{wd} * FR) / SV$$

(b) Concentration Leaving Water Droplet

$$C_{wd} = C_{w0} (1 - e^{(-KaL*ts)/60d})$$

(c) Adjusted Mass Transfer Coefficient

$$K_{aL} = K_L * ((T_l * u_s)/(T_s * u_l))^{-1/2}$$

(d) Overall Mass Transfer Coefficient

$$K_L = [(1/k_l) + (R * T)/(HLC * k_g)]^{-1}$$

(e) Liquid Film Mass Transfer Coefficient

$$k_l = k_l(CO_2) * ((MW_{CO_2})/(MW_{VOC}))^{1/2}$$

(f) Gas Film Mass Transfer Coefficient

$$k_g = k_{g(water)} * (MW_{water}/MW_{VOC})^{1/2}$$

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-6
Equations to Calculate Inhalation Exposure Concentration in the Shower (IEC_s)

Vlookup Version v0315

Parameter	Value	Units	Notes
IEC _s - Inhalation Exposure Concentration in shower	calculated	µg/m ³	see Table RW-7
S - Indoor air generation rate	calculated	µg/m ³ -min	see Table RW-7
R _{ae} - Air Exchange Rate	8.33E-03	1/min	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
D _s - Shower Duration for age group 1-8	45.7	min	see Table RW-8
	0.762	hour	see Table RW-8
D _t - Total Time in Shower Room for age group 1-8	65.7	min	see Table RW-8
D _s - Shower Duration for age group 8-15	42.1	min	see Table RW-8
	0.702	hr	see Table RW-8
D _t - Total Time in Shower Room for age group 8-15	66.4	min	see Table RW-8
D _s - Shower Duration for age group 15-31	32.8	min	see Table RW-8
	0.547	hr	see Table RW-8
D _t - Total Time in Shower Room for age group 15-31	62.8	min	see Table RW-8
C _{wd} - Concentration leaving water droplet	calculated	µg/l	see Table RW-7
FR - Shower Flow Rate	10	l/min	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
SV - Shower room air volume	6	m ³	Ibid
C _{w0} - Shower water concentration	OHM-specific	µg/l	EPC. See Table RW-1
K _{aL} - Adjusted mass transfer coefficient	calculated	cm/hr	see Table RW-7
t _s - Shower droplet time	2	seconds	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
d - Droplet diameter	1	mm	Ibid
60d = Droplet interfacial area	60	cm/hr-seconds	the specific interfacial area, 6/d, for a spherical droplet of diameter d (mm), multiplied by conversion factors, hr/3600 seconds and 100 mm/cm
K _L - Overall mass transfer coefficient	calculated	cm/hr	see Table RW-7
TI = Calibration water temperature of K _L	293	°K	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
µ _s - Water viscosity at T _s	0.596	cp	Ibid
T _s - Shower water temperature	318	°K	Ibid
µ _l - Water viscosity at T _l	1.002	cp	Ibid
k _l - Liquid film mass transfer coefficient	calculated	cm/hr	see Table RW-7
R - Universal Gas Constant	8.20E-05	atm-m ³ /mol-°K	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
T - Absolute temperature	293	°K	Ibid
HLC - Henry's Law Constant	OHM-specific	atm-m ³ /mol	see Table RW-7
k _g - Gas-film mass transfer coefficient	calculated	cm/hr	see Table RW-7
k _l (CO ₂) - Liquid-film mass transfer coefficient, CO ₂	20	cm/hr	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
MW _{CO2} - Molecular weight of CO ₂	44	g/mole	Ibid
MW _{VOC} - Molecular Weight of OHM	OHM-specific	g/mole	Ibid
k _g (H ₂ O) - Gas-film mass transfer coefficient, water	3000	cm/hr	Ibid
MW _{H2O} - Molecular weight of water	18	g/mole	Ibid

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-7
Inhalation Exposure Concentration in the Shower (IEC_s)

Vlookup Version v0315

Oil or Hazardous Material	Henry's Law Constant HLC atm-m3/mol	Molecular Weight MW g/mole	INTERIM CALCULATIONS						Inhalation Exposure Concentration IEC _{S(1.8)} (µg/m ³)	Inhalation Exposure Concentration IEC _{S(8.15)} (µg/m ³)	Inhalation Exposure Concentration IEC _{S(15.31)} (µg/m ³)
			gas-film mass transfer coefficient k _g (cm/hr)	liquid-film mass transfer coefficient k _l (cm/hr)	Overall Mass Transfer Coefficient K _L (cm/hr)	Adjusted Mass Transfer Coefficient K _{aL} (cm/hr)	Concentration Leaving Water Droplet C _{wd} (µg/l)	Indoor Air Generation Rate S (µg/(m3-min))			
N-NITROSODIMETHYLAM NE (NDMA)	1.82E-06	74.0822	1478.77	15.41	0.11	0.15	7.4E-05	1.2E-04	3.07E-03	2.94E-03	2.48E-03

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-8
Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table RW-9
URF - Unit Risk Factor	chemical specific	(µg/m ³) ⁻¹	see Table RW-9
RfD - Reference Dose	chemical specific	mg/kg-day	see Table RW-9
RfC - Reference Concentration	chemical specific	µg/m ³	see Table RW-9
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table RW-2
LADE - Lifetime Average Daily Exposure	chemical specific	µg/m ³	see Table RW-2
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table RW-3.
ADE - Average Daily Exposure	chemical specific	µg/m ³	Pathway specific. See Table RW-3.
EPC - Exposure Point Concentration	chemical specific	µg/L	see Table RW-1
VI ₍₁₋₈₎ - Volume Ingested for age group 1-8	1	L/day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix B-9.
VI ₍₈₋₁₅₎ - Volume Ingested for age group 8-15	2	L/day	Ibid
VI ₍₁₅₋₃₁₎ - Volume Ingested for age group 15-31	2	L/day	Ibid
RAF _{c/n} - Relative Absorption Factor for Cancer/Noncancer Effects	chemical specific	dimensionless	Pathway specific
EF - Exposure Frequency	1.00	event/day	
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure for age group 1-8	0.046	day/event	Calculated: Total time in shower room for a 1 - 8 year old (65.7 min) / day (1440 min).
ED _{inh} - Exposure Duration for inhalation exposure for age group 8-15	0.046	day/event	Calculated: Total time in shower room for a 8 - 15 year old (66.4 min) / day (1440 min)
ED _{inh} - Exposure Duration for inhalation exposure for age group 15-31	0.044	day/event	Calculated: Total time in shower room for a 15 - 31 year old (62.8 min) / day (1440 min)
EP ₍₁₋₈₎ - Exposure Period for age group 1-8	7	years	
EP ₍₈₋₁₅₎ - Exposure Period for age group 8-15	7	years	
EP ₍₁₅₋₃₁₎ - Exposure Period for age group 15-31	16	years	
BW ₍₁₋₈₎ - Body Weight for age group 1-8	17.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
BW ₍₈₋₁₅₎ - Body Weight for age group 8-15	39.9	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
BW ₍₁₅₋₃₁₎ - Body Weight for age group 15-31	58.7	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
AP _(lifetime) - Averaging Period for lifetime	70	years	
AP _(noncancer) - Averaging Period for noncancer	7	years	
IEC _s - Inhalation Exposure Concentration from showering	chemical specific	mg/m ³	Age group specific. See Table RW-7.
DA - Dose Absorbed through skin in shower	chemical specific	mg/cm ² -day	Age group specific. See Table RW-5.
OAE _{c/n} - Oral Absorption Efficiency for Cancer/Noncancer Effects	chemical specific	dimensionless	
SA ₍₁₋₈₎ - Surface Area for age group 1-8	7130	cm ²	50th percentile for females. Appendix Table B-2. MADEP. 1995. Guidance for Disposal Site Risk Characterization.
SA ₍₈₋₁₅₎ - Surface Area for age group 8-15	12800	cm ²	50th percentile for females. Appendix Table B-2. MADEP. 1995. Guidance for Disposal Site Risk Characterization.
SA ₍₁₅₋₃₁₎ - Surface Area for age group 15-31	16731	cm ²	50th percentile for females. Appendix Table B-2. MADEP. 1995. Guidance for Disposal Site Risk Characterization.
D _s - Shower Duration for age group 1-8	45.7	min	U.S. EPA. 1997. Exposure Factors Handbook. Table 15-21.
	0.76	hour	95th percentile ages 1-8. Weighted average of 1-8 year age groups: ((4x50)+(3x40))/7= 45.7 minutes
D _t - Total Time in Shower Room for age group 1-8	65.7	min	U.S. EPA. 1997. Exposure Factors Handbook. Tables 15-21,23. Equals the shower duration (Ds) plus the number of minutes spent in the shower room immediately after showering (95th percentile): Ds + ((4*20)+(3*20))/7 = 65.7 minutes
D _s - Shower Duration for age group 8-15	42.1	min	U.S. EPA. 1997. Exposure Factors Handbook. Table 15-21.
	0.70	hr	95th percentile ages 8-15. Weighted average of 8-15 age groups: ((4x40)+(3x45))/7 = 42.1 minutes
D _t - Total Time in Shower Room for age group 8-15	66.4	min	U.S. EPA. 1997. Exposure Factors Handbook. Tables 15-21,23. Equals the shower duration (Ds) plus the number of minutes spent in the shower room immediately after showering (95th percentile): Ds + ((4*20)+(3*30))/7=66.4 minutes
D _s - Shower Duration for age group 15-31	32.8	min	U.S. EPA. 1997. Exposure Factors Handbook. Table 15-21.
	0.55	hr	95th percentile ages 15-31. Weighted average of 15-31 year age groups: ((3x45)+(13x30))/16 = 32.8 minutes.
D _t - Total Time in Shower Room for age group 15-32	62.8	min	U.S. EPA. 1997. Exposure Factors Handbook. Tables 15-21,23. Equals the shower duration (Ds) plus the number of minutes spent in the shower room immediately after showering (95th percentile): Ds + ((3*30)+(13*30))/16 = 62.8 minutes
DM - Dermal Multiplier	chemical specific	dimensionless	If Kp < 0.5 cm/hr, then 0.2. Otherwise 1.

Table F-6
MassDEP Risk Assessment Shortform
Property 1
Wilmington, MA

Resident - Drinking Water: Table RW-9
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	CSF (mg/kg-day) ⁻¹	URF (µg/m ³) ⁻¹	RAF _{c-ing}	OAE _c	RfD mg/kg-day	RfC mg/m ³	RAF _{nc-ing}	OAE _{nc}	DM	Molecular Weight g/mole	log K _{ow}	Permeability Coefficient Kp cm/hr	Henry's Law Constant HLC atm-m ³ /mol
N-NITROSODIMETHYLAMINE (NDMA)	5.1E+01	1.4E-02	1	1						74.0822	-0.57	2.56E-04	1.82E-06

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Method 3 Risk Assessment for Resident Exposed to Chemicals in Drinking Water - Shortform 2012 (sf12rw)

Index

Tab

EPCs	Table RW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table RW-2: Equations to calculate cancer risks.
NC Eq	Table RW-3: Equations to calculate noncancer risks.
DA Eq	Table RW-4: Equations to calculate Absorbed Dermal Dose.
DA	Table RW-5: Dermal Absorbed Dose from Showering
IECs Eq	Table RW-6: Equations to calculate Inhalation Exposure Concentrations in the shower.
IECs	Table RW-7: Inhalation Exposure Concentration in the Shower
Exp	Table RW-8: Definitions and exposure factors.
Chem	Table RW-9: Chemical-specific data.

Spreadsheets designed by Andrew Friedmann, MassDEP
Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection
Office of Research and Standards
One Winter Street
Boston, MA 02108 USA
Telephone: (617) 556-1165
Fax: (617) 556-1006
Email: Lydia.Thompson@state.ma.us

Table F-7
 MassDEP Risk Assessment Shortform
 Property 2
 Olin OU3
 Wilmington, MA

ShortForm Version 10-12
 Vlookup Version v0315

Resident - Drinking Water: Table RW-1
Exposure Point Concentration (EPC) and Risk
Based on Resident Ages 1-31 (Cancer) and 1-8 (Noncancer)

Property 2

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 1.2E-05
 HI (all chemicals) =

Oil or Hazardous Material (OHM)	EPC (µg/L)	ELCR ingestion	ELCR dermal	ELCR inhalation	ELCR _{total}	Chronic			HQ _{total}
						HQ _{ing}	HQ _{derm}	HQ _{inh}	
N-NITROSODIMETHYLAMINE (NDMA)	1.2E-02	1.2E-05	2.6E-08	6.0E-07	1.2E-05				

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-2
Equations to Calculate Cancer Risk for Resident (Age 1-31 years)

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1-31)} * CSF$$

$$LADD_{ing(1-31)} = LADD_{ing(1-8)} + LADD_{ing(8-15)} + LADD_{ing(15-31)}$$

$$LADD_{ing(age\ group\ x)} = \frac{EPC * VI_x * RAF_{c-ing} * EF * ED_{ing} * EP_x * C}{BW_x * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm(1-31)} * CSF$$

$$LADD_{derm(1-31)} = LADD_{derm(1-8)} + LADD_{derm(8-15)} + LADD_{derm(15-31)}$$

$$LADD_{derm(age\ group\ x)} = \frac{DA_x * SA_x * EF * ED_{derm} * EP_x}{OAE_c * BW_x * AP_{lifetime}}$$

or, if outside "Effective Predictive Domain", then

$$LADD_{derm(age\ group\ x)} = DM * LADD_{ing(age\ group\ x)}$$

Cancer Risk from Inhalation

$$ELCR_{inh} = LADE_{(1-31)} * URF$$

$$LADE_{(1-31)} = LADE_{(1-8)} + LADE_{(8-15)} + LADE_{(15-31)}$$

$$LADE_{(age\ x)} = \frac{IEC_{S-x} * EF * ED_{inh-x} * EP_x}{AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
URF	OHM-specific	(µg/m ³) ⁻¹
LADD	age/OHM-specific	mg/kg-day
LADE	age/OHM-specific	µg/m ³
EPC	OHM-specific	µg/L
VI ₍₁₋₈₎	1	L/day
VI ₍₈₋₁₅₎	2	L/day
VI ₍₁₅₋₃₁₎	2	L/day
RAF _{c-ing}	OHM-specific	dimensionless
EF	1.00	event/day
ED _{ing & derm}	1	day/event
ED _{inh(1-8)}	0.046	day/event
ED _{inh(8-15)}	0.046	day/event
ED _{inh(15-31)}	0.044	day/event
EP ₍₁₋₈₎	7	years
EP ₍₈₋₁₅₎	7	years
EP ₍₁₅₋₃₁₎	16	years
C	0.001	mg/µg
BW ₍₁₋₈₎	17.0	kg
BW ₍₈₋₁₅₎	39.9	kg
BW ₍₁₅₋₃₁₎	58.7	kg
AP _(lifetime)	70	years
IEC _{S-x}	age/OHM-specific	µg/m ³
DA _x	age/OHM-specific	mg/cm ² -day
OAE _c	OHM-specific	dimensionless
SA ₍₁₋₈₎	7130	cm ²
SA ₍₈₋₁₅₎	12800	cm ²
SA ₍₁₅₋₃₁₎	16731	cm ²
DM	OHM-specific	dimensionless

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-3
Equations to Calculate Noncancer Risk for Resident Child (Age 1-8 years)

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{EPC * VI * RAF_{nc-ing} * EF * ED_{ing} * EP * C}{BW * AP}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD}$$

$$ADD_{derm} = \frac{DA * SA * EF * ED_{derm} * EP}{OAE_{nc} * BW * AP}$$

or, if DA is outside the "Effective Predictive Domain" of the dermal model, then

$$ADD_{derm} = DM * ADD_{ing}$$

Noncancer Risk from Inhalation

$$HQ_{inh} = \frac{ADE}{RfC}$$

$$ADE = \frac{IEC_S * EF * ED_{inh} * EP * C}{AP}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
RfC	OHM-specific	mg/m ³
ADD _{ing}	OHM-specific	mg/kg-day
ADD _{derm}	OHM-specific	mg/kg-day
ADE	OHM-specific	mg/m ₃
EPC	OHM-specific	µg/L
VI	1	L/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
EF	1.00	event/day
ED _{ing}	1	day/event
ED _{derm}	1	day/event
ED _{inh}	0.046	day/event
EP	7	years
C	0.001	mg/µg
BW	17.0	kg
AP _(noncancer)	7	years
IEC _S	OHM-specific	µg/m ³
DA	OHM-specific	mg/cm ² -day
OAE _{nc}	OHM-specific	dimensionless
SA	7130	cm ²
DM	OHM-specific	dimensionless

Resident - Drinking Water: Table RW-4
Equations to Calculate Absorbed Dermal Dose from Showering (DA)

Vlookup Version v0315

Model equations obtained from U.S. EPA (2001) Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim (<http://www.epa.gov/oswer/riskassessment/rags/index.htm>).

Steady State versus Non-Steady State for Organic Chemicals: The time for an organic chemical to reach steady state is a function of the chemical's molecular weight (MW) and its ability to traverse skin (expressed as a permeability constant, Kp). If an organic chemical does not reach steady state before the shower is over (i.e., time to reach steady state, t^* , is greater than the shower duration, D_s), Equation (1) is used to calculate the dermal dose for this non-steady state. For organic chemicals that have reached a steady state by the end of the shower, Equation (2) is used to calculate dermal dose.

Effective Predictive Domain: The model is not used for organic chemicals that fall outside its effective predictive domain. Strictly, chemicals with very large or very small Kow values are outside of the EPD. Chemicals outside the Effective Predictive Domain are identified with an asterisk in Tables B-2 and B-3 in the above citation as well as in Table V4 in the Vlookup (V) workbook. For these chemicals, the dermal dose is estimated as a function of the oral dose according to MA DEP (1995) Guidance for Disposal Site Risk Characterization and Equation (3) below. Note that the dermal dose in these cases is calculated as an average daily dose (ADD) or life-time average daily dose (LADD) and expressed in mg/kg-bw. Equation (3) is also presented in Tables DW-2 and DW-3.

(1) Organic Chemicals Inside Effective Predictive Domain - Non-Steady State

Equation for estimating dermally absorbed dose (DA) for organic chemicals when the shower duration (D_s) is less than or equal to the time to reach steady state (t^*).

$$DA = 2 * FA * C * Kp * Cw * [(6 * t * D_s) / p]^{1/2}$$

(2) Organic Chemicals Inside Effective Predictive Domain - Steady State

Equation for estimating DA for organic chemicals when D_s is greater than the time to reach t^* .

$$DA = FA * C * Kp * Cw * [(D_s / (1+B)) + 2 * t * ((1+3B+3B^2) / (1+B)^2)]$$

(3) Organic Chemicals Outside Effective Predictive Domain

$$(L)ADD_{derm} = DM * (L)ADD_{ing}$$

(4) Inorganic Chemicals

Equation for estimating DA for inorganic chemicals in water.

$$DA = C * Kp * Cw * D_s$$

Where the equations to calculate the input values are:

(a) Equation for predicting stratum corneum permeability constant (Kp) for organic chemicals:

$$Kp = 10^{[-2.8 + (0.66 * \log Kow) - (0.0056 * MW)]}$$

(b) Equation for calculating ratio of permeability of chemical in stratum corneum to permeability in viable epidermis (B)

$$B = Kp * (MW)^{1/2} / 2.6$$

(c) Calculations for calculating time to reach steady state (t^*):

When B is less than or equal to 0.6

$$t^* = 2.4 * t$$

When B is greater than 0.6

$$t^* = (b - (b^2 - c^2)^{1/2}) * I_{sc}^2 / D_{sc}$$

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-4
Equations to Calculate Absorbed Dermal Dose from Showering (DA)

Vlookup Version v0315

(d) Equations for calculating b and c

$$c = (1 + 3B + 3B^2)/(3 * (1+B)) \quad b = (2(1+B)^2/p) - c$$

(e) Equation for calculating lag time (t)

$$t = l_{sc}^2 / (6 * D_{sc})$$

(f) Equation for calculating effective diffusivity (D_{sc})

$$D_{sc} = 10^{-2.8 - (0.0056 * MW)} * l_{sc}$$

Parameter	Value	Units	Notes
DA _{event} - Absorbed dose per event per area skin exposed	calculated	mg/cm ² -day	see Table RW-4 and RW-5
FA - Fraction absorbed	OHM-specific	dimensionless	see Table RW-5
Kp - Stratum corneum (sc) permeability constant	OHM-specific	cm/hr	see Table RW-9
C - Conversion Factor	0.000001	m ³ /cm ³	
C _w - [OHM] in water, Exposure Point Concentration	OHM-specific	mg/m ³	see Table RW-1, expressed as µg/L
t - Lag time	calculated	hrs	Time for chemical to cross stratum corneum (Table RW-5)
D _s - Shower Duration	age-specific	hrs	see Table RW-6
LogK _{ow} - Octanol/water partition coefficient	OHM-specific	dimensionless	see Table RW-9
MW - Molecular Weight	OHM-specific	g/mole	see Table RW-9
t* - Time to reach steady state	calculated	hr	see Table RW-5
b - Empirical variable used to calculate t*	calculated	dimensionless	see Table RW-5
c - Empirical variable used to calculate t*	calculated	dimensionless	see Table RW-5
l _{sc} - Thickness of skin	0.001	cm	MA DEP (1995). Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
D _{sc} - Effective diffusivity for chemical transfer through the skin	calculated	cm ² /hr	see Table RW-5
B - Ratio of permeability of chemical in stratum corneum to permeability of chemical in viable epidermis	calculated	dimensionless	see Table RW-5

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-5
Dermal Absorbed Dose (DA) from Showering

Vlookup Version v0315

Oil or Hazardous Material	Ratio of perm. in stratum corneum to viable epidermis B	Lag Time (tau) hours	Effective Diffusivity of Chemical Transfer Through Skin Dsc (cm ² /hr)	Time to Reach Steady State t* hours	t* when B>0.6 hours	b	c	Absorbed Dose (1-8) DA (mg/cm ² -day)	Absorbed Dose (8-15) DA (mg/cm ² -day)	Absorbed Dose (15-31) DA (mg/cm ² -day)	Outside Effective Predictive Domain	Fraction Absorbed FA	Absorbed Dose (1-8) w/ FA term DA(1-8) (mg/cm ² -day)	Absorbed Dose (8-16) w/ FA term DA(8-16) (mg/cm ² -day)	Absorbed Dose (16-31) w/ FA term DA(16-31) (mg/cm ² -day)	Dermal Mult. DM
N-NITROSOD METHYLAMINE (NDMA)	8.49E-04	0.273	6.10E-07	0.66		3.0E-01	3.3E-01	4.06E-12	3.87E-12	3.32E-12		1	4.06E-12	3.87E-12	3.32E-12	

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-6
Equations to Calculate Inhalation Exposure Concentration in the Shower (IEC_s)

Vlookup Version v0315

Model equations obtained from Foster, S.A. and Chrostowski, P.C. (1987) Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presentation at the 80th Annual Meeting of APCA. New York, NY. June 21-26, 1987.

(1) Inhalation Exposure Concentration in the Shower.

$$IECs = [(S/R_{ae}) * (D_s + (e^{-R_{ae}Dt}/R_{ae}) - (e^{R_{ae}(Ds-Dt)}/R_{ae}))] / D_t$$

Where the equations to calculate the input values are:

(a) Indoor Air Generation Rate

$$S = (C_{wd} * FR) / SV$$

(b) Concentration Leaving Water Droplet

$$C_{wd} = C_{w0} (1 - e^{(-K_{aL} * ts)/60d})$$

(c) Adjusted Mass Transfer Coefficient

$$K_{aL} = K_L * ((T_l * u_s)/(T_s * u_l))^{-1/2}$$

(d) Overall Mass Transfer Coefficient

$$K_L = [(1/k_l) + (R * T)/(HLC * k_g)]^{-1}$$

(e) Liquid Film Mass Transfer Coefficient

$$k_l = k_l(CO_2) * ((MW_{CO2})/(MW_{VOC}))^{1/2}$$

(f) Gas Film Mass Transfer Coefficient

$$k_g = k_{g(water)} * (MW_{water}/MW_{VOC})^{1/2}$$

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-6
Equations to Calculate Inhalation Exposure Concentration in the Shower (IEC_s)

Vlookup Version v0315

Parameter	Value	Units	Notes
IEC _s - Inhalation Exposure Concentration in shower	calculated	µg/m ³	see Table RW-7
S - Indoor air generation rate	calculated	µg/m ³ -min	see Table RW-7
R _{ae} - Air Exchange Rate	8.33E-03	1/min	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
D _s - Shower Duration for age group 1-8	45.7	min	see Table RW-8
	0.762	hour	see Table RW-8
D _t - Total Time in Shower Room for age group 1-8	65.7	min	see Table RW-8
D _s - Shower Duration for age group 8-15	42.1	min	see Table RW-8
	0.702	hr	see Table RW-8
D _t - Total Time in Shower Room for age group 8-15	66.4	min	see Table RW-8
D _s - Shower Duration for age group 15-31	32.8	min	see Table RW-8
	0.547	hr	see Table RW-8
D _t - Total Time in Shower Room for age group 15-31	62.8	min	see Table RW-8
C _{wd} - Concentration leaving water droplet	calculated	µg/l	see Table RW-7
FR - Shower Flow Rate	10	l/min	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
SV - Shower room air volume	6	m ³	Ibid
C _{w0} - Shower water concentration	OHM-specific	µg/l	EPC. See Table RW-1
K _{aL} - Adjusted mass transfer coefficient	calculated	cm/hr	see Table RW-7
t _s - Shower droplet time	2	seconds	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
d - Droplet diameter	1	mm	Ibid
60d = Droplet interfacial area	60	cm/hr-seconds	the specific interfacial area, 6/d, for a spherical droplet of diameter d (mm), multiplied by conversion factors, hr/3600 seconds and 100 mm/cm
K _L - Overall mass transfer coefficient	calculated	cm/hr	see Table RW-7
TI = Calibration water temperature of K _L	293	°K	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
µ _s - Water viscosity at T _s	0.596	cp	Ibid
T _s - Shower water temperature	318	°K	Ibid
µ _l - Water viscosity at T _l	1.002	cp	Ibid
k _l - Liquid film mass transfer coefficient	calculated	cm/hr	see Table RW-7
R - Universal Gas Constant	8.20E-05	atm-m ³ /mol-°K	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
T - Absolute temperature	293	°K	Ibid
HLC - Henry's Law Constant	OHM-specific	atm-m ³ /mol	see Table RW-7
k _g - Gas-film mass transfer coefficient	calculated	cm/hr	see Table RW-7
k _l (CO ₂) - Liquid-film mass transfer coefficient, CO ₂	20	cm/hr	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-9.
MW _{CO2} - Molecular weight of CO ₂	44	g/mole	Ibid
MW _{VOC} - Molecular Weight of OHM	OHM-specific	g/mole	Ibid
k _g (H ₂ O) - Gas-film mass transfer coefficient, water	3000	cm/hr	Ibid
MW _{H2O} - Molecular weight of water	18	g/mole	Ibid

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-7
Inhalation Exposure Concentration in the Shower (IEC_s)

Vlookup Version v0315

Oil or Hazardous Material	Henry's Law Constant HLC atm-m3/mol	Molecular Weight MW g/mole	INTERIM CALCULATIONS						Inhalation Exposure Concentration IEC _{s(1.8)} (µg/m ³)	Inhalation Exposure Concentration IEC _{s(8-15)} (µg/m ³)	Inhalation Exposure Concentration IEC _{s(15-31)} (µg/m ³)
			gas-film mass transfer coefficient k _g (cm/hr)	liquid-film mass transfer coefficient k _l (cm/hr)	Overall Mass Transfer Coefficient K _L (cm/hr)	Adjusted Mass Transfer Coefficient K _{aL} (cm/hr)	Concentration Leaving Water Droplet C _{wd} (µg/l)	Indoor Air Generation Rate S (µg/(m ³ -min))			
N-NITROSODIMETHYLAMINE (NDMA)	1.82E-06	74.0822	1478.77	15.41	0.11	0.15	6.0E-05	1.0E-04	2.49E-03	2.38E-03	2.01E-03

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-8
Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table RW-9
URF - Unit Risk Factor	chemical specific	(µg/m ³) ⁻¹	see Table RW-9
RfD - Reference Dose	chemical specific	mg/kg-day	see Table RW-9
RfC - Reference Concentration	chemical specific	µg/m ³	see Table RW-9
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table RW-2
LADE - Lifetime Average Daily Exposure	chemical specific	µg/m ³	see Table RW-2
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table RW-3.
ADE - Average Daily Exposure	chemical specific	µg/m ³	Pathway specific. See Table RW-3.
EPC - Exposure Point Concentration	chemical specific	µg/L	see Table RW-1
VI ₍₁₋₈₎ - Volume Ingested for age group 1-8	1	L/day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix B-9.
VI ₍₈₋₁₅₎ - Volume Ingested for age group 8-15	2	L/day	Ibid
VI ₍₁₅₋₃₁₎ - Volume Ingested for age group 15-31	2	L/day	Ibid
RAF _{c/n} - Relative Absorption Factor for Cancer/Noncancer Effects	chemical specific	dimensionless	Pathway specific
EF - Exposure Frequency	1.00	event/day	
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure for age group 1-8	0.046	day/event	Calculated: Total time in shower room for a 1 - 8 year old (65.7 min) / day (1440 min).
ED _{inh} - Exposure Duration for inhalation exposure for age group 8-15	0.046	day/event	Calculated: Total time in shower room for a 8 - 15 year old (66.4 min) / day (1440 min)
ED _{inh} - Exposure Duration for inhalation exposure for age group 15-31	0.044	day/event	Calculated: Total time in shower room for a 15 - 31 year old (62.8 min) / day (1440 min)
EP ₍₁₋₈₎ - Exposure Period for age group 1-8	7	years	
EP ₍₈₋₁₅₎ - Exposure Period for age group 8-15	7	years	
EP ₍₁₅₋₃₁₎ - Exposure Period for age group 15-31	16	years	
BW ₍₁₋₈₎ - Body Weight for age group 1-8	17.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
BW ₍₈₋₁₅₎ - Body Weight for age group 8-15	39.9	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
BW ₍₁₅₋₃₁₎ - Body Weight for age group 15-31	58.7	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
AP _(lifetime) - Averaging Period for lifetime	70	years	
AP _(noncancer) - Averaging Period for noncancer	7	years	
IEC _S - Inhalation Exposure Concentration from showering	chemical specific	mg/m ³	Age group specific. See Table RW-7.
DA - Dose Absorbed through skin in shower	chemical specific	mg/cm ² -day	Age group specific. See Table RW-5.
OAE _{c/n} - Oral Absorption Efficiency for Cancer/Noncancer Effects	chemical specific	dimensionless	
SA ₍₁₋₈₎ - Surface Area for age group 1-8	7130	cm ²	50th percentile for females. Appendix Table B-2. MADEP. 1995. Guidance for Disposal Site Risk Characterization.
SA ₍₈₋₁₅₎ - Surface Area for age group 8-15	12800	cm ²	50th percentile for females. Appendix Table B-2. MADEP. 1995. Guidance for Disposal Site Risk Characterization.
SA ₍₁₅₋₃₁₎ - Surface Area for age group 15-31	16731	cm ²	50th percentile for females. Appendix Table B-2. MADEP. 1995. Guidance for Disposal Site Risk Characterization.
D _s - Shower Duration for age group 1-8	45.7	min	U.S. EPA. 1997. Exposure Factors Handbook. Table 15-21.
	0.76	hour	95th percentile ages 1-8. Weighted average of 1-8 year age groups: ((4x50)+(3x40))/7 = 45.7 minutes
D _t - Total Time in Shower Room for age group 1-8	65.7	min	U.S. EPA. 1997. Exposure Factors Handbook. Tables 15-21,23. Equals the shower duration (Ds) plus the number of minutes spent in the shower room immediately after showering (95th percentile): Ds + ((4*20)+(3*20))/7 = 65.7 minutes
D _s - Shower Duration for age group 8-15	42.1	min	U.S. EPA. 1997. Exposure Factors Handbook. Table 15-21.
	0.70	hr	95th percentile ages 8-15. Weighted average of 8-15 age groups: ((4x40)+(3x45))/7 = 42.1 minutes
D _t - Total Time in Shower Room for age group 8-15	66.4	min	U.S. EPA. 1997. Exposure Factors Handbook. Tables 15-21,23. Equals the shower duration (Ds) plus the number of minutes spent in the shower room immediately after showering (95th percentile): Ds + ((4*20)+(3*30))/7 = 66.4 minutes
D _s - Shower Duration for age group 15-31	32.8	min	U.S. EPA. 1997. Exposure Factors Handbook. Table 15-21.
	0.55	hr	95th percentile ages 15-31. Weighted average of 15-31 year age groups: ((3x45)+(13x30))/16 = 32.8 minutes.
D _t - Total Time in Shower Room for age group 15-32	62.8	min	U.S. EPA. 1997. Exposure Factors Handbook. Tables 15-21,23. Equals the shower duration (Ds) plus the number of minutes spent in the shower room immediately after showering (95th percentile): Ds + ((3*30)+(13*30))/16 = 62.8 minutes
DM - Dermal Multiplier	chemical specific	dimensionless	If Kp < 0.5 cm/hr, then 0.2. Otherwise 1.

Table F-7
MassDEP Risk Assessment Shortform
Property 2
Olin OU3
Wilmington, MA

Resident - Drinking Water: Table RW-9
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	CSF (mg/kg-day) ⁻¹	URF (µg/m ³) ⁻¹	RAF _{c-ing}	OAE _c	RfD mg/kg-day	RfC mg/m ³	RAF _{nc-ing}	OAE _{nc}	DM	Molecular Weight g/mole	log K _{ow}	Permeability Coefficient Kp cm/hr	Henry's Law Constant HLC atm-m ³ /mol
N-NITROSODIMETHYLAMINE (NDMA)	5.1E+01	1.4E-02	1	1						74.0822	-0.57	2.56E-04	1.82E-06

TABLE F-8
AIR CONCENTRATION OF VOCs WHILE SHOWERING - Private Well - Property 1, using full duration shower operation
RECEPTOR: RESIDENT - CURRENT LAND USE
Olin OU3
Wilmington, MA

PARAMETER	SYMBOL	ADULT VALUE	CHILD VALUE	UNITS	SOURCE	EQUATIONS
LIQUID-FILM MASS TRANSFER FOR CO2	Kl (CO2)	20	20	cm/hr	Foster & Chrostowski, 1987	$C_a(t) = (S/R) \times (e^{(R D_s)} - 1) \times e^{(-R t)}$
GAS-FILM MASS TRANSFER FOR WATER	Kg (H2O)	3000	3000	cm/hr	Foster & Chrostowski, 1987	
MOLAR GAS CONSTANT X TEMPERATURE	RT	0.024	0.024	atm-m³/mole	8.2e-5 atm-m3/mol-K x T1	$k_l = K_l(CO_2) \times (44/MW)^{1/2}$
REFERENCE TEMPERATURE	T1	293	293	K	Room temperature - 20 deg C	$k_g = K_g(H_2O) \times (18/MW)^{1/2}$
TEMPERATURE OF SHOWER WATER	Ts	318	318	K	Assumption [a]	
VISCOSITY OF WATER AT SHOWER TEMPERATURE	us	0.596	0.596	Cp	Foster & Chrostowski, 1987	$K_L = (1/k_l + RT/Hk_g)^{-1}$
VISCOSITY OF WATER AT REFERENCE TEMPERATURE	u1	1.002	1.002	Cp	Foster & Chrostowski, 1987	
SHOWER DROPLET FREE-FALL TIME	ts	2	2	sec	Assumption [b]	$K_{al} = K_L \times ((T_1 \times u_s) / (T_s \times u_l))^{-1/2}$
DROPLET DIAMETER	d	1	1	mm	Foster & Chrostowski, 1987	
FLOW RATE IN SHOWER	FR	10	10	l/min	Assumption [c]	$C_{wd} = C_w \times (1 - e^{-(K_{al} \times t_s)}) / (60d) \times 1000$
VOLUME OF SHOWER AREA	SV	6	6	m³	Assumption [d]	
AIR EXCHANGE RATE	R	0.00833	0.00833	min-1	Foster & Chrostowski, 1987	$S = C_{wd} \times FR / SV$
TIME IN SHOWER	Ds	42.6	32.4	min	Assumption [e]	
TIME AT WHICH CONCENTRATION IS BEING CALCULATED	t	42.6	32.4	min	USEPA, 2014	
Sources: Foster, S.A. and Chrostowski, P.C., 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower. [a] - Assumed to be 45 deg C (MassDEP, 1995) [b] - Assumed (MassDEP, 1995) [c] - Value for typical shower head, approximately 2.5 gal/min [d] - Assumes a room 6 feet wide, 6 feet long, and 6 feet high [e] - Assumed to be the resident water exposure time from USEPA, 2014 MassDEP, 1995 - Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan. Interim Final Policy. WSC/ORS-95-141. July 1995. Appendix B, Table B-9. USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.						

CHEMICALS OF POTENTIAL CONCERN (a)	CHEMICAL-SPECIFIC PARAMETERS			CALCULATED VALUES							
	GROUND WATER CONCENTRATION	MOLECULAR WEIGHT (MW)	HENRY'S LAW CONSTANT (H)	CHEMICAL-SPECIFIC LIQUID MASS-TRANSFER COEFFICIENT (kl)	CHEMICAL-SPECIFIC GAS MASS-TRANSFER COEFFICIENT (kg)	MASS TRANSFER COEFFICIENT (KL)	TEMPERATURE CORRECTION OF MASS-TRANSFER COEFFICIENT	ANALYTE CONCENTRATION IN WATER DROPLET	RELEASE RATE OF ANALYTE TO AIR (S)	ROOM AIR CONCENTRATION ADULT (C_a(t))	ROOM AIR CONCENTRATION CHILD (C_a(t))
	(b) (mg/l)	(c) (g/mol)	(c) (atm-m3/mol)	(cm/hr)	(cm/hr)	(cm/hr)	(Kal) (cm/hr)	(Cwd) (ug/l)	(ug/m³-min)	(ug/m³)	(ug/m³)
N-Nitrosodimethylamine	1.5E-05	7.4E+01	1.8E-06	1.5E+01	1.5E+03	1.1E-01	1.5E-01	7.5E-05	1.2E-04	4.5E-03	3.5E-03

Notes:
(a) Chemicals included in this table are those selected as COPC in Table 2.3-1 and that were identified as "sufficiently volatile" per Table B-6.1.
(b) GW Concentrations are identified in Table 3.2-1.
(c) Henry's Law Constant and Molecular Weight were sourced from the USEPA Regional Screening Level (RSL) calculator (November, 2017).

Prepared by: JPK 5/29/2018
Checked by: LCF 5/29/2018

TABLE F-9
AIR CONCENTRATION OF VOCs WHILE SHOWERING - Private Well - Property 2, using full duration shower operation
RECEPTOR: RESIDENT - CURRENT LAND USE
Olin OU3
Wilmington, MA

PARAMETER	SYMBOL	ADULT VALUE	CHILD VALUE	UNITS	SOURCE	EQUATIONS
LIQUID-FILM MASS TRANSFER FOR CO2	Kl (CO2)	20	20	cm/hr	Foster & Chrostowski, 1987	$C_a(t) = (S/R) \times (e^{(R D_s)} - 1) \times e^{(-R t)}$
GAS-FILM MASS TRANSFER FOR WATER	Kg (H2O)	3000	3000	cm/hr	Foster & Chrostowski, 1987	
MOLAR GAS CONSTANT X TEMPERATURE	RT	0.024	0.024	atm-m³/mole	8.2e-5 atm-m3/mol-K x T1	$k_l = K_l(CO_2) \times (44/MW)^{1/2}$
REFERENCE TEMPERATURE	T1	293	293	K	Room temperature - 20 deg C	$k_g = K_g(H_2O) \times (18/MW)^{1/2}$
TEMPERATURE OF SHOWER WATER	Ts	318	318	K	Assumption [a]	
VISCOSITY OF WATER AT SHOWER TEMPERATURE	us	0.596	0.596	Cp	Foster & Chrostowski, 1987	$K_L = (1/k_l + RT/Hk_g)^{-1}$
VISCOSITY OF WATER AT REFERENCE TEMPERATURE	u1	1.002	1.002	Cp	Foster & Chrostowski, 1987	
SHOWER DROPLET FREE-FALL TIME	ts	2	2	sec	Assumption [b]	$K_{al} = K_L \times ((T_l \times u_s) / (T_s \times u_l))^{-1/2}$
DROPLET DIAMETER	d	1	1	mm	Foster & Chrostowski, 1987	
FLOW RATE IN SHOWER	FR	10	10	l/min	Assumption [c]	$C_{wd} = C_w \times (1 - e^{-1k_{al} \times t_s}) / (60d) \times 1000$
VOLUME OF SHOWER AREA	SV	6	6	m³	Assumption [d]	
AIR EXCHANGE RATE	R	0.00833	0.00833	min-1	Foster & Chrostowski, 1987	$S = C_{wd} \times FR / SV$
TIME IN SHOWER	Ds	42.6	32.4	min	Assumption [e]	
TIME AT WHICH CONCENTRATION IS BEING CALCULATED	t	42.6	32.4	min	USEPA, 2014	
Sources: Foster, S.A. and Chrostowski, P.C., 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower. [a] - Assumed to be 45 deg C (MassDEP, 1995) [b] - Assumed (MassDEP, 1995) [c] - Value for typical shower head, approximately 2.5 gal/min [d] - Assumes a room 6 feet wide, 6 feet long, and 6 feet high [e] - Assumed to be the resident water exposure time from USEPA, 2014 MassDEP, 1995 - Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan. Interim Final Policy. WSC/ORS-95-141. July 1995. Appendix B, Table B-9. USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, USEPA, February 6, 2014.						

CHEMICALS OF POTENTIAL CONCERN (a)	CHEMICAL-SPECIFIC PARAMETERS			CALCULATED VALUES							
	GROUND WATER CONCENTRATION	MOLECULAR WEIGHT (MW) (c)	HENRY'S LAW CONSTANT (H)	CHEMICAL-SPECIFIC LIQUID MASS-TRANSFER COEFFICIENT (kl)	CHEMICAL-SPECIFIC GAS MASS-TRANSFER COEFFICIENT (kg)	MASS TRANSFER COEFFICIENT (KL)	TEMPERATURE CORRECTION OF MASS-TRANSFER COEFFICIENT	ANALYTE CONCENTRATION IN WATER DROPLET	RELEASE RATE OF ANALYTE TO AIR (S)	ROOM AIR CONCENTRATION ADULT (C _a (t))	ROOM AIR CONCENTRATION CHILD (C _a (t))
	(b) (mg/l)	(g/mol)	(c) (atm-m3/mol)	(cm/hr)	(cm/hr)	(cm/hr)	(Kal) (cm/hr)	(Cwd) (ug/l)	(ug/m³-min)	(ug/m³)	(ug/m³)
N-Nitrosodimethylamine	1.2E-05	7.4E+01	1.8E-06	1.5E+01	1.5E+03	1.1E-01	1.5E-01	6.1E-05	1.0E-04	3.6E-03	2.9E-03

Notes:
(a) Chemicals included in this table are those selected as COPC in Table 2.3-1 and that were identified as "sufficiently volatile" per Table B-6.1.
(b) GW Concentrations are identified in Table 3.2-1.
(c) Henry's Law Constant and Molecular Weight were sourced from the USEPA Regional Screening Level (RSL) calculator (November, 2017).